JUL 7 1922

June 29, 1922

Engineering News-Record

Devoted to Civil Engineering and Contracting
McGraw-Hill Company, Inc.

Packing Triangulation Equipment up a California Mountain

How a Power Company Carried Out a Triangulation Survey

By W. Mussetter

Hydraulic Design of Bridge Waterways

By Ivan E. Houk

What Was Found Out About Road Construction in the First Pittsburg, Cal., Test

General Motors Trucks

GMC Special One-Ton Dump Truck; One Yard Capacity

Built Particularly for Emergency Loads of Contracting Materials

The GMC One-Ton Special Speed Dump Truck offers the building or road contractor a flexible, fast and economical motor truck of one-yard capacity with every facility for rapid loading and unloading.

It fills a long-felt want for a real, high-grade dump truck of small size and its uses in contracting, municipal, coal and other bulk material businesses are wide and varied.

The chassis is the standard GMC one-ton chassis with all of the exclusive GMC improvements and the body is a "General Utility" type, combining platform, stake and tight-side body in one. The hoist is a horizontal type, driven by a shaft from the power-take-off of the engine without sprockets or chains.

For emergency hauling, for carrying mixed road materials and for all small cargoes of bulk materials this Truck is ideal equipment and its reception has been most appreciative everywhere.

Increased Repeat Orders

The repeat order business which is increasing daily is the finest possible proof of the performance of GMC trucks in all kinds of trucking. More and more users are replacing GMC equipment with new GMC equipment after years of faithful service and are also standardizing upon GMC trucks for every new unit that is added to their hauling equipment.

Motor truck users are appreciative of the value in actual service of the exclusive improvements which have been built into GMC trucks—improvements that make possible more actual hours of hauling than is averaged by other trucks.

Such exclusive features as GMC Removable Cylinder Walls, the GMC Two-Range Transmission, Removable Valve Lifter Assemblies, Pressure Lubrication, Instantaneous Governor, and many others all contribute directly to better motor truck operation and to lower costs for gasoline and oil.

Lower Replacement Costs

Moreover, these improvements all help to reduce materially the time necessary to make replacements and adjustments and consequently keep these trucks operating more continuously. There is not a single wearing part of a GMC truck which is not easily replaceable and which cannot be renewed at a reasonable expense.

Motor truck maintenance costs are not dependent so much upon the actual labor involved as upon the time which the truck is laid up and is a total loss to its owner. In reducing this loss GMC construction offers the truck operator an opportunity to cut maintenance costs such as never before has been available.

In addition GMC trucks have established a new standard of value because they offer more refinement and more improvements than can be obtained in any other truck, regardless of its cost. The chassis prices at the factory are as follows: One Ton, $1295; Two Ton, $2375; Three and One-Half Ton, $3600; Five Ton, $3950; Tax to be added.

GENERAL MOTORS TRUCK COMPANY

Division of General Motors Corporation
PONTIAC, MICHIGAN
Dealers and Service in Most Communities

A Consolidation of Engineering News and Engineering Record — McGraw-Hill Company, Inc.—JAMES H. McGRAW, President

ENGINEERING NEWS-RECORD

DEVOTED TO CIVIL ENGINEERING AND CONTRACTING

E. J. MEHREN, Editor

Volume 88 — NEW YORK, JUNE 29, 1922 — Number 26

Mixing Pleasure and Business

QUARTERLY meetings of the American Society of Civil Engineers, in different sections of the country, were prescribed by the new constitution both to distribute geographically the public activities of the society and to provide opportunity for more general technical discussion than the old monthly meetings at New York permitted. The first quarterly meeting at Dayton last April was an unquestioned success. Attendance was high and interest intense. The meeting last week at Portsmouth while planned in part to resemble the Dayton meeting turned out to be little more than the usual summer convention, that is a pleasant rendezvous for a comparatively small number of members sufficiently provided with leisure and funds to take a few days vacation in June. That an effort was made to furnish forth a technical menu is indicated by the number and variety of the technical papers on the program. But unfortunately the program suffered from these two virtues. Conditions of weather and architecture made the meeting hall a most unpleasant place and the papers themselves, all excellent presentations, were so many and of so great a variety as to weary the hearer. The Dayton meeting was of professional interest alone; the summer convention seeks to combine pleasure and technical discussion. It may be that it can be done, but those trying it in the future should consider the great advantage of concentrating the technical program on a single and live subject.

To the New Secretary

IF THE new secretary of the American Society of Civil Engineers has at his command a fairy godmother ready to bestow the traditional gift he will do well to ask for temporary deafness. The amenities of his new position require that he listen courteously and attentively to the hundreds of his employers who will claim his private ear. From Bingville and from New York, out of the East and out of the West, progressive and conservative, reactionary and anarchist will they come to him, to tell him just what is the matter with the society and more particularly what is the matter with those who differ from them on society practices and policies. For a few months Professor Dunlap will be the most talked-to man in the profession. Judicious deafness will be his only relief. Thus protected he may proceed to study the complications of his new office and to learn his new job unhampered by the few who have come to believe that their own ideas and private controversies are of more importance than, or at least are necessary to, the good of the society.

Cast-Iron Water Pipe Problems

THE outlook for a joint revised standard specification for cast-iron pipe, to be substituted by both the American and the New England Water Works Association for their respective specifications, is encouraging. The great need seems to be research work on a chemical specification for the metal, on the proper relation between bending moment and flexure in test bars, and on ensuring a better pipe coating than is now generally provided. This is attested by the paper on "Tars for Pipe Coating," abstracted in our issue of June 1, p. 913, and by the paper and committee report on cast-iron pipe abstracted elsewhere in this issue. Of great interest and importance to the water-works engineer and superintendent is the paper, also abstracted in this issue, by Prof. Gillespie, on centrifugally cast-iron pipe. The evident feeling of members of the pipe specification committees of both the American and New England Associations, and of other engineers and water-works men as well, is that the centrifugal process may go far towards solving the cast-iron pipe problem. The question of a better or more uniformly reliable coating will remain, whether sand- or centrifugally-cast pipe be the leading material ten or twenty years hence. The foundry men are making a further contribution of funds for research on the chemical and physical sides of cast-iron pipe and are working out the possibilities of the promising centrifugal process. Who will provide funds for the much needed investigation of pipe coating?

Rainfall vs. Judgment

OBSERVED fact, scientific deduction, and practical judgment come together in quite remarkable manner in the problem of bridges and floods that is discussed by Ivan E. Houk in this issue. Many years of observation since the deluge against which Noah provided have not removed the subject of heavy rainfalls from the realm of the unknown and unexplored, and the engineer will probably always be in the position of taking chances when he undertakes to proportion a bridge waterway. Mr. Houk expresses this clearly, by indicating that it is hardly possible to make every bridge opening large enough to carry the most intense flood flows that have occurred anywhere. Scientific deduction warrants the transfer of experience, in a degree, but practical judgment usually says that it does not pay to go to an extreme in safety provisions. The record of every spring, particularly of a wet spring such as this year's, brings an unpleasant surprise in the number of bridges washed out. Nevertheless the value of these structures is so minute a part of our total bridge investment that it is a question of engineering calculation, or rather trained judgment, whether the loss is large enough to warrant the great extra expenditure that would be needed if all bridges were built to survive the maximum possible flood. However, as has been urged more than once in these columns, there is a value in bridge permanence that is not measured in terms of direct physical losses. In other words, it pays to build bridges much more resistant than a mere estimate of the chances of washout would

indicate. If we must take chances in pitting economy against rainfall possibilities, it is better to favor the side of safety, which is somewhat different from the general trend of past practice.

Secure Foundations

TWO kinds of bridge failures by washout come to notice in the continuous record of such failures: those caused by exceptional floods, and those which occur during ordinary high water. The latter are considered by the public to be due to engineering error, and justly so, since an adequate foundation would have prevented them; and, in fact, one or two recent failures of this type reflect quite obviously on the caliber of the engineering applied to the structures in question. Washouts which are caused by exceptional floods, on the other hand, are usually looked upon as unpreventable, as cases in which man has lost in playing against nature's hidden game. But from a broader viewpoint even these washouts must be charged against foundations rather than against floods: they would not have occurred if thoroughly resistant foundations had been provided. If, then, the bridge engineer will fix his aim on making his foundations secure against scour, the matter of calculating flood volume and waterway area reduces to secondary importance, and the hydraulic phenomena merely determine the backwater but do not greatly affect the bridge. We believe that all bridge planning should be carried out on this basis. Waterway areas would still be calculated, but not primarily for the purpose of reducing the flow velocity below the scour limit. The flood problem in bridge design would be virtually limited to that kind of flood failure—a kind unfortunately too common—in which the partly submerged superstructure is torn away from its support by reason of deficient anchorage. Model bridge specifications still ignore the necessity of providing strong anchorage of bridge superstructures to piers, but the importance of such anchorage is a timely matter for consideration.

Borings as an Insurance Measure

AS A MEASURE of insurance against construction delays, improper design, and, in extreme cases, failure of the finished structure, sub-surface exploration by drilling has not received the wide acceptance by engineers which it deserves. This applies particularly to large-scale operations where millions are at stake. In planning the big dams and the deep rock tunnels of New York's Catskill aqueduct, the necessity for extensive preliminary borings became established as a recognized policy of the engineering department and the success of the finished project attests to the wisdom of the course followed. It is not enough, however, merely to make borings. There must be an intelligent interpretation of their results so that the information gained may be put to practical use. James F. Sanborn, in his article on p. 1024 of the last issue, draws upon a wide experience on the Catskill work and elsewhere in presenting data on boring methods and machines and an analysis of the information they disclose. There are many engineers who fail to realize that earth and rock samples are not the only indications of sub-surface conditions which borings yield. An important and oft-neglected factor is the matter of water and its relation to the porosity of the material penetrated by the drill. There is a growing tendency to attach far more importance than formerly to the proper collection and permanent storage of boring records. Boring records should be permanently preserved and made available to others in the same way that rainfall and run-off data are now collected and recorded.

Drawbridge Wrecks and Steamers

UNDER modern transportation conditions the blocking of a main freight highway, as occurred last week at the eastern end of the Lincoln Highway through the destruction of a drawbridge by a steamer is probably as far-reaching in its effects as the interruption of a main railway line. We say probably, because study of road traffic has not yet gone far enough to warrant a more positive statement; better information as to this phase of the Hackensack River bridge wreck ought to develop in the course of the next few weeks. Even now, however, the gravity of the accident is sufficiently apparent that the question will be asked whether bridge engineers have done all they can toward protecting drawbridges from ships. Fortunately the facts of the case furnish a satisfactory answer to two parts of this question: first, whether engineers build their bridges sufficiently robust, and second, whether the swingbridge is inherently vulnerable and ought to be replaced by another type.

On the first point, the Hackensack River bridge was in general as robust in its detail construction as a bridge can reasonably be made; it lacked the thin, relatively fragile bar or latticed members that were responsible for the extent of the damage in some prior wrecks of the same kind. Even a much heavier and stockier bridge would hardly have fared much better. There is nothing in the present accident, therefore, to indict modern swingbridge practice.

On the other point the answer is supplied by comparison with another drawbridge collision that occurred quite recently within half a dozen miles of the Hackensack crossing. The Newark Bay bascule draw of the Central R.R. of New Jersey was struck by a ship, which rammed the side of the track span or supporting girder on which the bascule rested, bending it so badly as to necessitate replacement. Less damage was done than in last week's collision, but this is primarily a matter of the force of the blow struck by the vessel. The inherent liability to injury by collision seems to be about the same for either type.

Bridge engineering practice, then, is in no way shown at fault by the Hackensack River wreck. It is hardly conceivable that every bridge can be built so as to resist the impact from a moving mass of several thousand tons weight, and there are sure to be other drawbridge wrecks so long as ships run into bridges. For this reason thought should be given to protecting drawbridges more effectively than is now done, by placing adequate clusters of guard piling at the ends of the pier fenders, which ordinarily are quite flimsy. Dock and ferry practice has developed methods which prove their efficiency daily, and which could be applied at moderate cost to protecting a drawbridge. This, however, is as far as the constructing engineer can go toward eliminating these unnecessary bridge accidents. The safety of drawbridges will always in large measure rest on the care of shipmasters, and justice requires that they should be held to a strict accounting for their responsibility.

The Pittsburg Road Tests

THE official report on the Pittsburg (Cal.) road tests cannot be expected until after the field work has been completed, which means several months at least. Meantime highway engineers want to know something of the progress and trend of observations there. With the co-operation of engineers in charge and after a study of the work at Pittsburg, a member of *Engineering News-Record's* staff prepared the article appearing elsewhere in this issue. For the most part it is a bare statement of facts and preliminary findings which do not warrant definite conclusions. There are, however, certain indications from the test which should be worth while to record, as follows:

By thoroughly pulverizing and compacting the subgrade, in layers, adobe soil can be made practically impervious to moisture, and thus treated it is a fairly good material on which to lay pavement. If swelling in adobe soil can thus be reduced it will be good practice in constructing highways through adobe cuts to carry the excavation to an extra depth of 18 in. or 2 ft. and then to treat the material the same as in fills. This process is suggested because damage to pavement results from the action of adobe in both cuts and fills.

The continuous traffic tests have given another opportunity to observe the durability of concrete. Even after carrying more than 3,000,000 tons in heavy trucks there was practically no *wear* of the pavement surface; paint marks before traffic began were plainly visible.

Where there was anything in the path of continuous traffic to cause repeated impact, such as uneven joints, serious and extensive damage resulted. The fact that nearly all the disintegration on the test road began at construction joints or at transverse cracks emphasizes the need of designs that will strengthen these most vulnerable points, reduce impact to a minimum. In the repair of the test road various types of special joints were put in where new concrete was poured and comparative results on these joints will be interesting, but it should be remembered that at best these repairs are patches and that an absolute test can be made only where such joints are put in at the same time and under the same conditions as the pavement itself.

Not only the construction joints, but also the edges of the pavement, appear to be vulnerable and the frequency with which cracks and breaks start at the edges warrants special attention. Sections with thickened edges which would have inherently the best protection against failure of this sort have made a very favorable showing as to relative strength and durability for a given thickness of slab.

Motor-truck traffic was applied to the Pittsburg test road with such intensity that in the 51-day operating interval between Nov. 9, 1921, and Jan. 28, 1922, the total duty imposed on the pavement was equivalent to the truck duty of an average California road for a period of 25 to 40 years. That disintegration of failed sections was correspondingly accelerated is not surprising, particularly since proper repairs were almost impossible under the conditions of the test.

On the whole the Pittsburg tests are providing data of many kinds that will have an important bearing on the design of concrete roads. While too much credit cannot be given the Columbia Steel Co. for its initiative in undertaking the test, the scope and importance of the research have passed beyond that which any company alone could handle successfully. It is fitting that the U. S. Bureau of Public Roads and the California Highway Commission should share the direction and financing of further work and it is good news that they will continue with another series of experiments at the same site when the present tests are finished.

Construction's Step Forward

IF THE promise of the organizing meeting be fulfilled the construction industry took a great step forward last week when the American Construction Council was organized in Washington. There have been attempts before to bring a number of branches of the construction industry together, but never to co-ordinate the efforts of all of the elements. The response was remarkable. All elements were represented at Washington and all voiced appreciation of the magnitude of the opportunity and faith in the ability of the leaders to accomplish the desired results.

Regarding the prime object of the council little needs be said. It is so important that its necessity is granted by all. The industry must establish itself in the confidence of the public. It may work for its own ends but those ends must never run counter to the public's interest. In other words, it must serve itself by constantly rendering better service to the people at large.

There are other ends in view that are not so apparent. The new council should make the industry articulate. No one knows today what the construction industry really is. The statistics have never been gathered. All elements have not been sought out. These things the new council will do. Before the industry can properly interpret itself to the bankers, to the transportation interests, to other industries, to the public, it must interpret itself to itself. It must know its own magnitude and its own importance before it can have an adequate conception of its power, of its influence on the community, and of its responsibilities.

One of the difficulties which will be met is that the council is confronted with a well matured industry. It must therefore combat self-satisfaction and conservatism. The electrical industry, the automobile industry, and the motion picture industry are examples of what can be accomplished with industrial youth. Youth always means enthusiasm. In construction we have age—almost old age. It will be much harder to generate enthusiasm, to secure the virility and freshness of viewpoint which an industry awakening to new consciousness of responsibility should have.

But though it needs enthusiasm and a new viewpoint, it must, because it is dealing with long entrenched practices, with conservative policies and conservative men, carefully avoid, in its early days, controversial subjects. There are many rocks on which it could instantly go to pieces. If it will choose only those subjects on which it is apparent that agreement can be reached, then, when all of the elements have learned to work together and to have confidence in each other, it will be soon enough to take up those difficult problems that right now would raise destructive controversy.

Judging by the men who have participated in the organizing work and who were at Washington, high purpose will be combined with virility and with a studious avoidance of needless and harmful controversy. The council is well launched. There is a big goal ahead. There is promise of success.

Results of Heavy Traffic on Pittsburg Test Road

Trucks Travel 96,000 Miles—Wave Motion in Concrete Slab Plotted—Moisture Percolates Slowly in Rolled Adobe Subgrade—Tests of Wider Scope to Follow

THE operation of an average of 30 fully loaded 3½- and 5-ton trucks over the concrete test road at Pittsburg, Cal., described in *Engineering News-Record*, Dec. 29, 1921, p. 1049, was continued until Jan. 28, 1922, at which time 4 of the 13 sections were rated as failures. At that time the subgrade had not yet become saturated and because it was apparent that an excessive amount of traffic would be required to break down the concrete on dry adobe traffic was temporarily suspended at the suggestion of the regional director of the U. S. Bureau of Public Roads.

In the interim those portions of the road on which the paving was no longer serviceable were replaced with new concrete. The results of the test so far have proved to be of such value that the test will be continued under the joint supervision of the U. S. Bureau of Public Roads, the California State Highway Commission and the Columbia Steel Co. When the tests are completed or when the destruction of the pavement is carried as far as may be considered worth while, it is probable that an entirely new and more comprehensive series of experiments will be undertaken at the same site and under the same joint supervision.

Results.—While the replacement of destroyed portions of the pavement was under way measurements taken during traffic were plotted and studied. Some of the results noted by those in charge of the tests are as follows:

(1) Thorough rolling of the sprinkled adobe subgrade, layer by layer, compacted it to such an extent that, after being flooded for three months, horizontal percolation was less than 1 ft. and vertical percolation less than 2 ft. (2) Edges and corners of the slab, particularly at construction joints and transverse cracks where there may be some deflection under load, are the weakest portions and ordinarily will be the first to fail under heavy loads or adverse subgrade conditions. (3) Because of the excessive deflection and corresponding destruction effect caused by impact a greater percentage of the time and money spent on pavements might well be devoted to getting a perfectly smooth surface, particularly at construction joints. (4) A truck moving over a pavement produces wave motion tending to lift the slab just in front of the deflection caused by the front wheels. (5) A 6-in. slab, after deflecting under a loaded 5-ton truck, does not recover its former position for more than 2 hr.; after long-continued traffic this rate of return is somewhat slower, due, perhaps, to fatigue of materials. (6) Concrete surfaces will carry about 3,500,000 tons of traffic on solid-rubber tires without abrasion; the marks of the finishing tool on the concrete surface still are apparent and even the paint marks with which the pavement was laid off in squares are plainly visible.

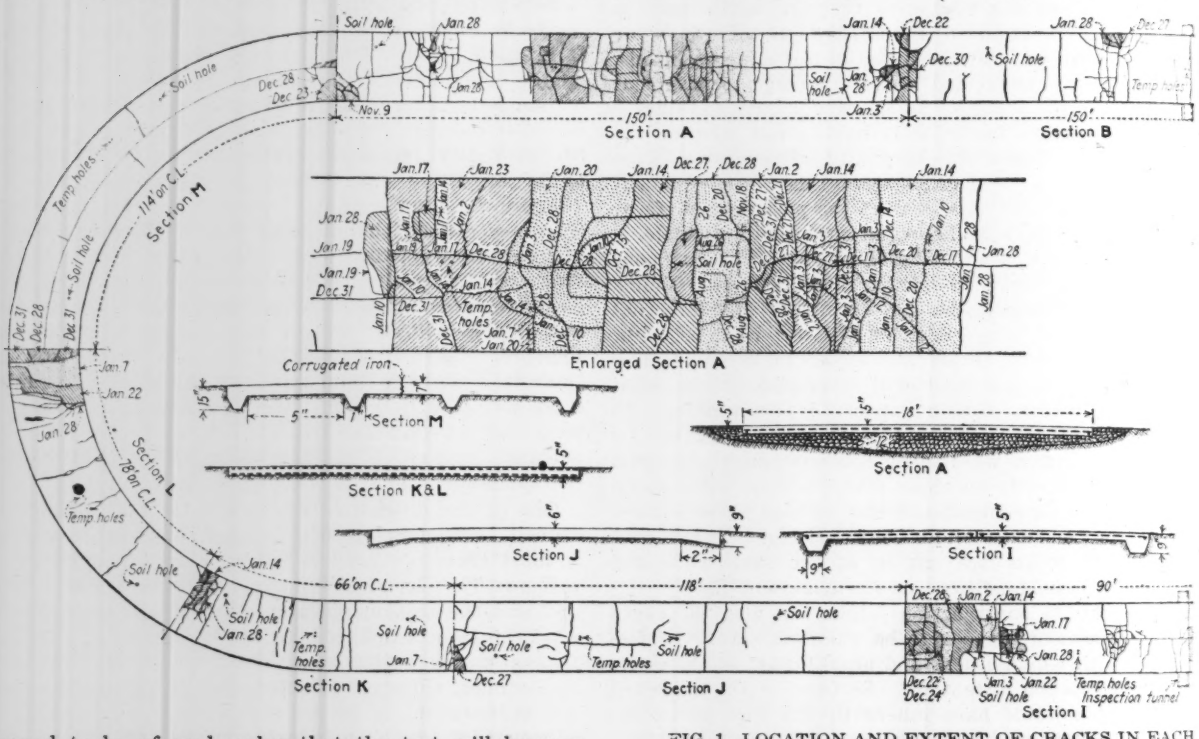


FIG. 1. LOCATION AND EXTENT OF CRACKS IN EACH
Shaded areas show concrete that was actually broken out by traffic. There is no difference between the cross-

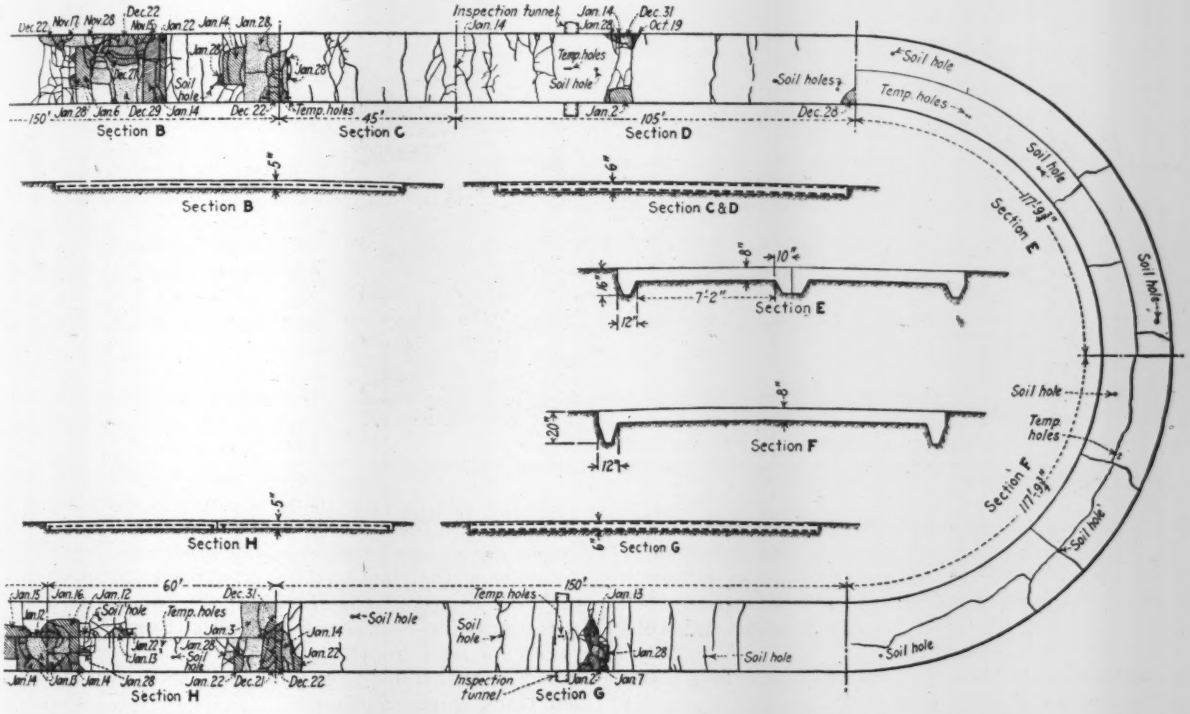
The continuous traffic of loaded trucks was started on the pavement Nov. 9, 1921. From then until Nov. 21, when the first rain came, the edges of all slabs were without support. In most of the slabs the unsupported width at each edge was about 2 ft. Subsequent to Nov. 21 intermittent rains caused a swelling of the subgrade under the edges of the pavement and the slab deflections under traffic were decreased.

Under this condition, however, the edges of the slab

were on wet subgrade while the center was comparatively dry, as was shown by subgrade samples taken through test holes in the slab. In order to saturate the subgrade and thereby increase the pavement deflections the side ditches were flooded Dec. 21, there being no change meantime in the traffic.

With water in the side ditches standing only a few inches below pavement level and with a rainfall during the traffic totaling 7½ in., traffic was continued for a month. At the end of this period tests showed no considerable saturation of the subgrade under the slabs except at the edges. When traffic was stopped Jan. 28, to be resumed when the subgrade became thoroughly saturated, a total of 3,688,000 tons had passed over the pavement. The weights of the trucks varied from 14,500 to 27,400 lb. gross and the total distance traveled on the pavement by trucks of all weights was 96,000 miles.

Slow Percolation Into Subgrade.—Subgrade samples



SECTION AFTER TRAFFIC TOTALING 3,688,000 TONS
hatched and stippled areas, these being used to differentiate sections which failed at different times.

are taken through test holes in the slabs by means of a 2-in. auger, 56 in. long. Rain water, of course, has had access to the subgrade where cracks and breaks have occurred, but even at these points there has been no penetration of moisture into the subgrade exceeding 2 ft. in depth, nor has the moisture from the side ditches penetrated the 4 ft. of horizontal distance from the edge of the slab to the test hole. Analysis of samples taken from the test holes—and this condition holds for the entire length of the roadway—showed no increased moisture content under central portions of the slabs after water had been standing in the side ditches for three months.

The fact that the adobe subgrade is almost impervious, or at least that the penetration of moisture is exceedingly slow, was a surprise to those in charge of the work and is regarded as an important discovery. If further moisture tests show a continuation of the very slow rate of percolation it is believed that a valuable means will have been developed for decreasing the destructive effect on pavement of expansion and contraction in adobe subgrades. Special importance, therefore, attaches to the method of preparing the subgrade, which was as follows:

The concrete pavement was laid for its entire length on a fill about 3 ft. high, the fill material being the black adobe common o the bottomland of California valleys and noted for its excessive expansion and contraction with changes in moisture content. The fill was placed in 6-in. layers, each layer being 30 ft. wide, thus extending 6 ft. beyond the edge of the slab on each side. Each layer was lightly sprinkled and then rolled with a 14-ton roller which gave a compression of 450 lb. per inch of tire. This pulverized all clods and compacted the surface, which was finally scarified slightly so as to give a surface that would readily blend with the next 6-in. layer. This method of compacting the subgrade is estimated to add less than $1,000 per mile to the cost of preparing the roadbed.

Truck Causes Deflection Wave.—A series of static deflection readings was taken with a truck approaching and passing over one of the observation tunnels. These readings were then plotted as contours by connecting points of equal deflection with a smooth curve. Without going into the question of why the diagrams differ it may be noted that they have one common characteristic in that they show a wave effect ahead of and behind the truck, with the slab returning to its normal position more slowly than it was deflected. The slow return to normal position was made the subject of a separate study.

The difference between the amount of shear carried across construction joints at the warmest and the coldest times of day was made the subject of a series of

tests on eight construction joints at which the pavement deflections were measured on the surface with micrometer gages reading to thousandths of an inch. For this work a truck was brought up with its front wheels very close to the construction joint and its weight entirely on one slab, near the edge. Deflections were measured at 6:15 a.m. and 2:30 p.m., these hours being taken to represent the daily maximum and minimum temperatures. Measurements were made at the corner of each slab, *i.e.*, at the edge of the pavement and near the end of the construction joint. The truck used had a gross weight of 14,560 lb. with 5,360 lb. on the front wheels and 9,200 lb. on the rear wheels.

During construction of the pavement a ½-in. redwood board was put in at each construction joint to separate abutting slabs, no tar or other filler being used. These boards were loose when the morning readings were taken. The average morning deflections were 0.022 in. on the corner of the slab under the truck and 0.001 in. for the corner of the adjoining slab. In the afternoon measurements the slabs had expanded enough to develop considerable pressure on the board and due to shear being carried through the joint the deflection of both slabs was about the same. The average deflection for all of the joints tested in the afternoon was 0.005 in. for the corner on which the truck stood and 0.004 in. for the adjoining corner.

FIG. 2. REPAIR OF BREAK 90 FT. LONG IN SECTION A
In foreground are transverse 12 x 12-in. timbers. Beyond them is the 3 x 12-in. grillage-type of patch.

Maintenance and Repairs.—During continuous traffic tests the trucks were stopped at 10 a.m. and 3 p.m. for 15-min. intervals and at these times, as well as at noon and at night, every effort was made to protect the concrete, where breaks were developing, with hot asphalt and screenings, precast concrete slabs, oil macadam on brick and plank base, etc.

Except for triangular breaks at construction joints and cracks that did not interfere with traffic, there were no serious breaks that required patching until about Dec. 20. On Dec. 27 breaks in several sections were so bad that four timber grillages were put in. It was not thought advisable to make these wide enough for two lines of traffic and hence after this date only a single line of trucks could operate.

Where large breaks occurred several means of making temporary repairs were tried, but the most satisfactory was found to be 12 x 12-in. transverse timbers extending over an 8-ft. width of the roadway. The section to be patched was first excavated to a depth such that the upper surface of the 12 x 12-in. timbers would be about 1 in. above the adjoining pavement. This excess height was found to be about right as after a very little traffic the timbers were forced down to the same level as the adjoining concrete surfaces. Steel plates were placed on the surface of the concrete at both ends of such patches to bridge the joints and reduce impact.

FIG. 3. TEST ROAD WITH SIDE DITCHES FLOODED
By thoroughly compacting fill on which pavement was laid, water standing in side ditches three months did not saturate subgrade.

In patches made as above described no longitudinal timbers were laid. In another type of patch (Fig. 2), which was cheaper but less satisfactory, this method was used: After removing the broken concrete and excavating the subgrade to just the right depth, 3 x 12-in. stringers were laid, on these 3 x 12-in. plank were placed transversely and finally, 3 x 12-in. rails or surfacing was laid longitudinal with the roadway and at the same level as the adjoining pavement surfaces. Three-eighth-inch steel plates were also used with this 3 x 12-in. patch, held in place by spikes driven through holes in the plate and into the timber. In the absence of any basis for making an exact comparison of conditions in the several slabs at the time traffic was stopped a plan or map was used to record the cracks in the various sections. In the drawing reproduced herewith (Fig. 1), shading represents area in which the pavement was so badly broken up that it had to be patched in some way in order that traffic might continue.

The four sections which had failed to the extent that they were rated as being incapable of carrying more traffic were *A*, *B*, *H* and *I*. Considerable portions of

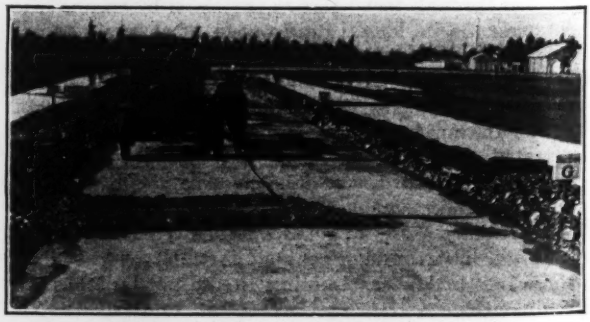


FIG. 4. REPAIR OF BREAK AT CONSTRUCTION JOINT
Between Sections G and H; 12 x 12-in. timbers with crushed rock at edges to decrease impact.

the concrete in these sections were replaced with unreinforced 6-in. concrete patches. Some portions of these sections, however, were still sound and these are being used in the continuation of the tests.

In pouring new concrete in the several repaired sections means of strengthening the construction joints—the weakest points—are being applied. Sketches showing several of the special joints which are being tried out appear in the article following this one.

Another feature of the reconstructed road will be the measurement of pressure intensities between the slab and the subgrade at various points. This is expected to show where there is arch action in the slab and to what degree temperature changes affect pressures on the subgrade. For these measurements twelve Goldbeck soil cells are to be used, nine being put over a tunnel and three at slab corners.

TABLE OF ESTIMATED COSTS PER MILE OF THE 13 PAVEMENT SECTIONS USED IN THE PITTSBURG TEST ROAD

Sections	Thickness (Inches)	Concrete Cu.Yd. Per Mile	Concrete Per Cu.Yd.	Concrete Per Mile	Tons Steel Per Mile	Steel Cost Per Mile	Rock Ballast Per Mile	Total Cost Per Mile	Unity Comparison
"A"	5	1,467	$13.40	$19,658	20	$1,400	$5,475	$26,533	1.26
"B"	5	1,467	13.40	19,658	20	1,400	.....	21,058	1.00
"C"	6	1,760	13.05	22,968	55	3,850	.....	26,818	1.27
"D"	6	1,760	13.05	22,968	55	3,850	.....	26,818	1.27
"E"	8	2,695	12.35	33,283	..	.....	.....	33,283	1.58
"F"	8	2,608	12.35	32,209	..	.....	.....	32,209	1.52
"G"	6	1,760	13.05	22,968	69	4,830	.....	27,798	1.32
"H"	5	1,467	13.40	19,658	24	1,680	.....	21,338	1.01
"I"	5	1,695	13.05	22,120	24	1,680	.....	23,800	1.13
"J"	6 & 9	1,858	13.05	24,247	..	.....	.....	24,247	1.15
"K"	5	1,467	13.40	19,658	69	4,830	.....	24,488	1.16
"L"	5	1,467	13.40	19,658	55	3,850	.....	23,508	1.11
"M"	7	2,401	12.70	30,493	..	.....	.....	30,493	1.44

Total cost is given for pavement only, no subgrade work included. All sections 18 ft. wide. Cost of reinforcing steel was $70.00 per ton in place; cement 2.75 per bbl., delivered; common labor $4 per 8 hr.

Unit costs of plain concrete were figured as follows:
From 1,001 cu.yd. to 1,500 cu.yd. per mile @ $13.40 per cu.yd.
From 1,501 cu.yd. to 2,000 cu.yd. per mile @ $13.05 per cu.yd.
From 2,001 cu.yd. to 2,500 cu.yd. per mile @ $12.70 per cu.yd.
From 2,501 cu.yd. to 3,000 cu.yd. per mile @ $12.35 per cu.yd.

The interests of the Bureau of Public Roads in the tests are represented by Dr. L. I. Hewes, deputy chief engineer, who is stationed at San Francisco. For the California Highway Commission, Austin B. Fletcher, chief engineer, is giving personal attention to the tests. Lloyd Aldrich and John B. Leonard, consulting engineers of San Francisco, have charge of the engineering staff. Harold Hamill is in charge of field observations.

All Old Dams in New Jersey To Be Inspected

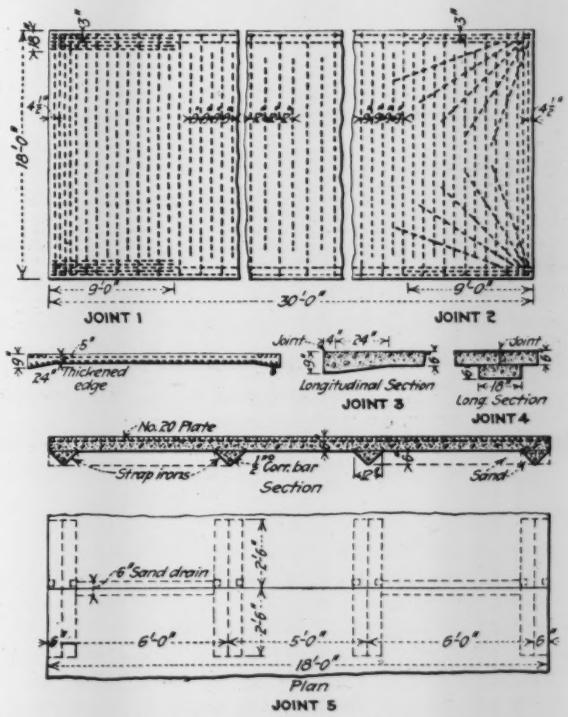
An investigation of some 500 old dams in the state of New Jersey is to be made by engineers of the State Department of Conservation and Development. The first work to be done will be on dams which are thought by the county boards of freeholders to be most dangerous. It is expected that it will take two or three years to complete the entire survey. The department has power to order owners of dams to repair them if it things that life and property below the structures are imperiled. The department was given supervision over the erection and maintenance of dams and reservoirs within the state in 1912, but because of lack of funds it has heretofore confined its supervision to new structures. Plans for all proposed dams which will raise the water level more than 5 ft. or which have a drainage area of more than one square mile must be approved by the department.

Experiments With the Construction Joints in Concrete Pavement

Eight Special Joints in Pittsburg (Cal.) Test Road Show Means of Strengthening Slab Where Breaks Usually Start

BECAUSE of the high percentage of breaks that started at construction joints in the Pittsburg (Cal.) test road special joints designed to strengthen the slab at these points are being used in the new concrete poured to replace portions of the pavement that had been broken down. Eight types of special joints were used as shown in the accompanying illustrations.

Joints 1 and 2 involve no change in the cross-section of the slab, which is 5 in. thick in the center and has



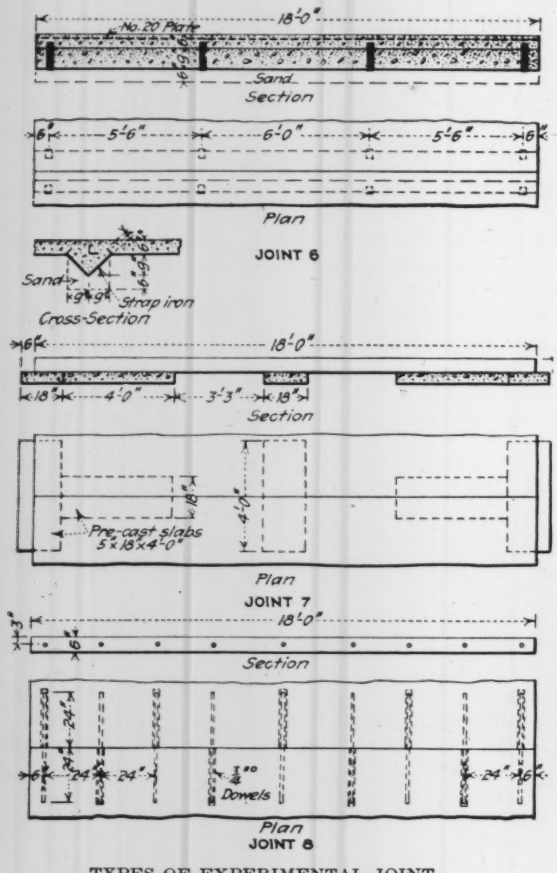
TYPES OF EXPERIMENTAL JOINT FOR CONCRETE SLABS USED IN PITTSBURG TEST ROAD

1 and 2, show reinforcing in opposite ends of same slab; 3, thickened end of slab, no steel used; 4, foundation for abutting slab ends; 5, V-shaped concrete stringers under joint.

thickened edges. All reinforcing in this section is ¾-in. round bars. The extra bars which are placed transversely and diagonally at the corners have 4-in. hooks on each end, while the extra longitudinal bars have 4-in. hooks on one end. All are placed 1 in. or 1¾ in. from the top of the slab. The extra transverse bars at the joints bring the spacing down to 4½ in. on centers. The extra longitudinal bars are placed so that the spacing becomes 3 in. on centers. The steel used is a special silicon steel of high tensile strength.

Joint 3 involves no reinforcing steel and is simply a thickening of the end of the slab. The dimensions of the thickened portion are shown in the sketch. This very much resembles the thickened edge used in some slab designs.

Joint 4 is a transverse beam of the same thickness



TYPES OF EXPERIMENTAL JOINT

6, V-shaped beam transversely under joint; 7, precast slabs laid in subgrade under joint; 8, dowels to carry shear from slab to slab.

as the slab and is laid under the joint to give equal support to both the abutting ends.

Joint 5 consists of longitudinal V-shaped beams or stringers of concrete with 1½ x ¼-in. iron straps projecting up into one of the slabs so as to bond the beam to that slab. Tar paper is laid on the other half of the beam to prevent bonding to the adjacent slab. Sand drains are provided to take away any water that might collect under the central stringer. A 20-gage metal plate bent into the shape of an angle iron is set on the joint transverse to the roadway. This is painted with oil before being laid to prevent bonding to the concrete and is intended to form a concealed joint that will break evenly across the pavement.

Joint 6 consists of a transverse V-shaped concrete beam placed under the joint and attached to the concrete on either side by means of 1½ x 1¼-in. strap irons similar to those used in joint No. 5. This joint has an angle iron along the line of the joint similar to that used in joint No. 5. It is also drained by a sand-filled ditch excavated below the beam.

Joint 7 consists of precast slabs laid in the subgrade, as shown in the sketch, before the concrete was poured. These were standard size slabs already on hand which were formerly used in patching. In placing these slabs it was suggested that because of the labor cost in handling the unwieldy pieces it would ordinarily be cheaper to pour the concrete in place.

Joint 8 consists of steel rods serving as dowels to carry shear from the end of one slab into the one abutting, without bonding the two together. To prevent bond each dowel was wrapped with tarred paper for half its length.

Cofferdam Sheeting Stands After Cribwork Is Removed

WATER 22 ft. deep at the deepest place stands behind the barrier of vertical sheeting and waling timbers shown by the accompanying illustration. Originally this sheeting and waling formed the face of a stone-filled, timber-crib cofferdam. When the construction for which the cofferdam was provided had been completed a derrick was used to take out the stone and to tear out the cribwork. The dismantling was done without attempt to preserve the sheeting as the only object was to let water quickly into the space

SHEETING OF CRIB COFFERDAM HOLDS 22 FT. OF WATER

since it was a needed extension of the fore-bay of a water-power plant. But the sheeting and waling remained standing and J. T. McLellan, construction manager says: "We should be glad to have explanations from engineers who are interested in hydraulics."

The cofferdam was required in an operation to extend the municipal power plant on the Winnipeg River at Kenora, Ontario. It was about 100 ft. long, and sustained a head of water of 22 ft. at its deepest section. At this point the crib was made 30 ft. wide. It was built of 6 x 8-in. timbers drift-pinned together, filled with rock, sheathed with 3-in. T. & G. plank and toe-filled on the water side. The design was based on the assumption that at the deep part it would require 900 cu.yd. of rock to resist the pressure. The contractors were the Backus-Brooks Co., International Falls, Minn., with J. T. McLellan as construction manager.

Highway System to Comprise 180,000 Miles

It is estimated by the U. S. Bureau of Public Roads that the 7-per cent system of interstate and intercounty roads provided for by the Federal Highway Act will comprise 180,000 miles. Proposed systems have been received by the bureau from all but eight states. They are plotted on a large map of the United States and carefully examined as to co-ordination with the roads of adjacent states and service to all sections of the country. Where co-ordination is not satisfactory conferences are held with all interested state highway officials and routes adjusted.

Hydraulic Design of Bridge Waterways

Each Opening Requires Individual Design—Formulas Are Makeshifts—Cloudburst Data—Applying 1913 Flood and Pueblo Flood Figures—Scour Velocities—Other Considerations

By Ivan E. Houk
City Engineer, Dayton, Ohio
Formerly Hydraulic Engineer with Miami Conservancy District

Permanent bridges require permanent, i.e., correctly-proportioned, waterway areas if the risk of heavy loss in floods is to be avoided. Highway engineers have felt the need for better information on waterway proportioning, as shown by requests to "Engineering News-Record" for data and comparisons of flood formulas. Mr. Houk's article is prepared in answer to these requests. His experience makes it authoritative. The emphatic statement that run-off formulas should not be relied upon in bridge proportioning is likely to be influential in raising the level of practice.—Editor.

HYDRAULIC design of bridge waterways should be based on engineering judgment, not on ancient formulas. In other words the design should be made by a rational method, similar in principle to the rational method used in sewer design, rather than by the blind application of run-off formulas developed in other localities.

The design of each opening is an individual problem, and the designer will find it important to give careful consideration to all the various affecting factors. These include not only the topographic and geological data of the site, but also the frequency and magnitude of floods, the velocities of flow, the cost of the structure, and the probable damage resulting from failure. He requires a fair understanding of rainfall and run-off conditions throughout the areas under his supervision, of the velocities and conditions under which scour occurs, and of the general hydraulic principles involved in the flow of water through open channels and through contracted openings. As a general rule the more complete his knowledge of the above matters is, the better will be his designs.

The main questions to be answered in designing bridge waterways for flood flow are: first, what maximum rate of run-off should be provided for; and second, what maximum velocity should be allowed or will exist through the opening. There are, of course, many other matters to be considered, such as the shape of the opening, the shape and alignment of piers where more than one span is necessary, the permissible ponding, and so forth; but these are really of secondary importance. Knowing the maximum amount of flow to be cared for and the greatest mean velocity through the bridge a simple division of the former by the latter gives the minimum area of the opening to be provided below the high water line. The details of shape, spans, and so forth may then be worked out.

Formulas at Best Makeshifts—There may be, and probably are, locations where some one formula will give satisfactory values of run-off to be used in designing bridge waterways. But even in such cases it is believed that a rational consideration of each individual problem will give better results. The studies of the Miami Conservancy District showed that for the smaller areas, say of less than 500 square miles, the McMath formula gave fairly satisfactory results. Yet when it came to designing bridge waterways each problem was considered separately, without recourse to any formula. Certainly no formula should be used unless its limitations are understood and unless it has been proven to be fitted to the given conditions.

Maximum Rate of Run-off—The determination of the maximum rate of run-off to be designed for is not an easy matter, especially in the case of the smaller drainage areas, where the problem is most often met. For the larger rivers, such as the Susquehanna, or the Mississippi, the problem is not so difficult. Fairly reliable long-time records of discharge and stage are generally available on such streams; moreover, there are not the wide variations between maximum recorded discharge and maximum possible discharge which generally exist for the smaller watersheds.

Cloudburst Floods—Maximum rates of run-off on small drainage areas are caused by the rather erratic cloudbursts which occur here and there during the summer months. Consequently one drainage area may have experienced in recent years a cloudburst flood of 1,000 sec.-ft. per square mile, while an adjoining area of similar size and characteristics may not have experienced one of as much as 100 sec.-ft. per square mile within the memory of the oldest inhabitants. In July, 1918, a cloudburst near New Carlisle, O., caused a run-off of about 2,200 sec.-ft. per square mile from an area of about 6.7 sq.mi. (*Engineering News-Record*, Sept. 22, 1921, p. 480); in the drainage area next east, however, a run-off rate as great as 200 sec.-ft. per square mile has never been known. Other similar cases might be cited.

What discharges to provide for in such instances must necessarily be decided by engineering judgment after careful consideration of the various affecting factors. No simple or exact solution is possible. To blindly design bridge waterways for all such areas by using a run-off formula which would give either of the above values would be absurd.

If a relatively great factor of safety can be obtained at only a slight increase in cost, the extra expenditure probably would be justified; if not, it would be better to design for a smaller maximum run-off rate and take the risk of damage by a greater flood. It is believed that in the great majority of cases it will not be necessary to design for the maximum possible cloudburst rates. Local conditions will determine the procedure in each instance. The writer recently designed a bridge waterway to care for a maximum run-off of about 0.4 in. per hr. from an area of about 8 sq.mi., 260 sec.-ft. per square mile, believing it better to take the risk of damage at some future date than to go to greater expense at the present time.

Cloudbursts Infrequent—Cloudbursts such as the one that occurred at New Carlisle are comparatively infrequent as regards a given area, despite the facts that notices of such storms having fallen somewhere are printed in the newspapers every week or so during the summer months, and that there are probably some cloud-

bursts each year which are not heard of owing to their having fallen where no serious damage could result. If the areas covered by such storms are compared with the areas on which they might just as easily have fallen it will be seen that the expectancy of occurrence for a given area is remarkably small.

For instance, in the Miami Valley during the nine years since 1913 there have been two cloudburst floods of unusual proportions: the New Carlisle flood mentioned above and one other, for which no description has ever been published. No detailed surveys were made of the latter, but personal inspection within a few days of its occurrence showed that the runoff rate from an area of 6 sq.mi. was comparable with that at New Carlisle. Either of these storms might just as well have fallen on any other six-square-mile area in the 3,600 sq.mi. contained in the Miami Valley above Hamilton. Consequently it may be said, roughly, that the chance of a

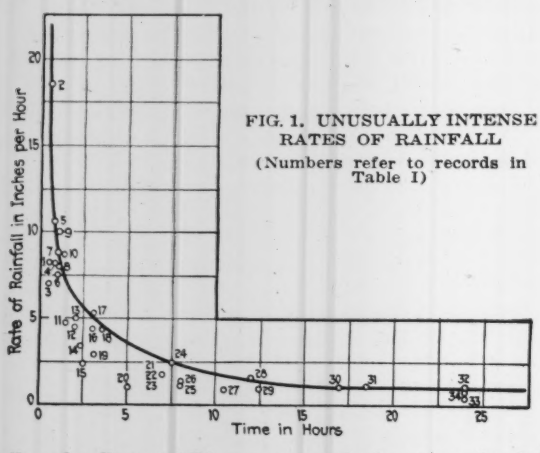


FIG. 1. UNUSUALLY INTENSE RATES OF RAINFALL
(Numbers refer to records in Table I)

similar cloudburst falling on a particular 6 sq.mi. of the Miami Valley once in 4.5 years is about 1 : 600, or, in other words, that one storm of such proportions may be expected on a given area of that size once in 2,700 years. If it is assumed that two additional storms occurred in remote sections of the Valley and were not noted by the Conservancy engineers, the expectancy would be once in 1,350 years, still comparatively infrequent.

This simply shows that in the case of unusually small drainage areas it is not at all necessary to design bridge openings for the maximum possible floods. Of course such reasoning does not apply to locations where the topography and atmospheric conditions are of a kind to cause the formation of cloudbursts, "thunderstorm-breeding spots," as R. E. Horton terms them (see *Monthly Weather Review*, April, 1921, pp. 193 and 202).

Cloudburst Rainfall—The collected climatological data published by the United States Weather Bureau contain but little on cloudburst rainfall, owing to the fact that such storms, being comparatively small in size, generally fall between the regularly maintained rain gaging stations. During recent years, however, the Weather Bureau officials have done some valuable work in securing data on cloudbursts from local residents such as depths of precipitation from measurements in pails, tubs, and the like. The results of these investigations have been published in various issues of the Monthly Weather Review.

Table I gives a few of the most unusual rainfall records found in the Weather Bureau publications, together with a few secured from other sources. Asterisks are used to designate those not measured in standard rain gages. Records are included in which the duration of the precipitation varied from 30 min. to 24 hrs., although the storms of the longer durations are not generally termed cloudbursts. It is quite likely that during each storm, especially the longer ones, there were periods of shorter duration in which the rates of rainfall were much higher than the average given in the table. Unfortunately, none of the cloudbursts listed fell where recording gages are maintained.

The records included in the table show that cloudbursts are not limited to any particular section of the United States but may fall in practically all parts of

TABLE I—UNUSUALLY INTENSE RAINFALLS FOR DURATIONS OF 24 HOURS OR LESS

Ref. No.	Location	Date	Amount, Inches	Duration Hr.	Duration Min.	Rate in In. Per Hr.
1	Biscayne, Fla.	Mar. 28, 1874	4.10	0	30	8.20
2	Guinea, Va.	Aug. 24, 1906	9.25*	0	30	18.50
3	Logansport, Md.	July 7, 1879	3.50	0	30	7.00
4	Newton Square, Pa.	Aug. 5, 1843	5.5*	0	40	8.25
5	Fort Mohave, Ariz.	Aug. 28, 1898	8.00*	0	45	10.67
6	Tridelphia, W. Va.	July 19, 1888	6.90	0	55	7.53
7	Palmetto, Nev.	Aug. 1890	8.80	1	00	8.80
8	Cincinnati, Ohio	June 3, 1921	8.0*	1	00	8.00
9	Catskill, N. Y.	July 26, 1819	10.0*	1	00	10.00
10	Campo, Cal.	Aug. 12, 1891	11.5	1	20	8.63
11	Cambridge, Ohio	July 16, 1914	7.09**	1	30	4.73
12	Taborton, N. Y.	Aug. 10, 1920	8.95*	2	00	4.47
13	Brandywine Hundred, Del.	Aug. 5, 1843	10.00*	2	00	5.00
14	Roney's Point, W. Va.	July 19, 1888	8.0*	2	20	3.43
15	Fort Meade, S. Dak.	June 13, 1907	6.01	2	30	2.40
16	Catskill, N. Y.	July 26, 1819	13.0*	3	00	4.33
17	Concord, Pa.	Aug. 5, 1843	16.0*	3	00	5.33
18	Newton Twp., Pa.	Aug. 5, 1843	13.0*	3	00	4.33
19	Alton, Ill.	July 13, 1912	9.22*	3	10	2.91
20	Albuquerque, N. Mex.	Oct. 9, 1865	5.20	5	00	1.04
21	Quanah, Tex.	June 4, 1891	12.25	7	00	1.75
22	Boggs Flats, Colo.	June 3, 1921	12.0*	7	00	1.71
23	York Pa.	June 25, 1884	12.0*	7	00	1.71
24	Catskill, N. Y.	July 26, 1819	18.0*	7	30	2.40
25	Flatbush, N. Y.	Aug. 22, 1843	9.0	8	00	1.12
26	Griffin, Ga.	Aug. 8, 1883	10.38	8	00	1.30
27	White Plains, N. Y.	Oct. 9, 1877	9.70	10	30	0.92
28	Taylor, Tex.	Sept. 9, 1921	19.5	12	00	1.63
29	Larrabee, Iowa	June 23, 1891	12.95	12	24	1.04
30	St. George, Ga.	Aug. 28, 1911	18.0	17	00	1.06
31	Montell, Tex.	June 29, 1913	20.6	18	30	1.11
32	Hearne, Tex.	June 28, 1899	24.0	24	00	1.00
33	Beaulieu, Minn.	July 20, 1909	10.75	24	00	0.45
34	Altapass, N. C.	July 15, 1916	22.2	24	00	0.92

** Greater part of the rainfall fell in less than 30 minutes.
* Believed reliable although not measured in a standard rain gage.

the country. There may be, and probably are, differences in the areas covered by the intense precipitation and in the frequency of occurrence of cloudbursts in the different regions; but the data readily available at present are not sufficient to determine this definitely. It is believed that *cloudbursts are fully as frequent and as intense in the eastern states as in the Rocky Mountain regions*, if not more so; and that the conclusions to the contrary which have been drawn by some people are the result of the more rugged topography in the west, rather than the result of actual differences in the occurrence of cloudburst phenomena.

Fig. 1 shows the rates of rainfall plotted against their duration, for the various records of Table I. A curve has been drawn through the higher points to indicate, for the different periods of time, about what intensity may possibly occur sometime in the future.

Discharge Rates from Small Areas—Table II gives some of the more unusual maximum rates of discharge which have been observed for areas smaller than 200 square miles. No rates less than 200 sec.-ft. per square mile are included. Most of the records were determined from measurements of cross-section and high-water slope after the flood had passed and consequently cannot be relied upon absolutely. The records are shown graphically in Fig. 2, rates of discharge being plotted as ordinates against drainage areas as abscissas. Curve A has been drawn through the higher points.

TABLE II—MAXIMUM RATES OF DISCHARGE FROM SMALL AREAS

Ref. No.	Stream	Location	Drainage Area, Sq.Mi.	Date	Max. Rate In Sec.-Ft. Per Sq.Mi.	Authority
1	Doker's Hollow	Pa.	0.6	June, 1917	4,000	Unpublished data
2	Mad Creek	Le Roy, N. Y.	1.5	June, 1916	2,000	Eng. Rec. 6-24-16
3	Arroyo	Near Pueblo, Colo.	1.8	June, 1921	1,060	Pr. A. S. C. E. Dec. '21, p. 772
4	Cherryvale Creek	Cherryvale, Kan.	2.0		930	Tr. A. S. C. E. 1905, p. 200
5	Moraine Run	Moraine City, Ohio	2.6	Sept., 1916	346	Eng. News-Rec. 5-1-19
6	W. Fork Honey Creek	New Carlisle, Ohio	3.5	July, 1918	1,000	Eng. News-Rec. 9-22-21
7	Mill Brook	Sherburne, N. Y.	5.0	Sept., 1905	262	Tr. A. S. C. E. 1914, p. 564
8	E. Fork Honey Creek	New Carlisle, Ohio	6.7	July, 1918	2,210	Eng. News-Rec. 9-22-21
9	Blue Ribbon Creek	Near Pueblo, Colo.	6.7	June, 1921	1,360	Proc. A. S. C. E., Dec. 1921, p. 772
10	Cameron Arroyo	Near Pueblo, Colo.	7.3	June, 1921	1,900	Proc. A.S.C.E., Dec., 1921, p. 772
11	Sawpit Canyon	Los Angeles, Cal.	7.4	1889	550	Los Angeles Flood Control Rep.
12	Osteen Arroyo	Near Pueblo, Colo.	7.8	June, 1921	1,160	Proc. A.S.C.E., Dec., 1921, p. 772
13	Mill Creek	Erie, Pa.	9.3	Aug., 1915	800	Eng. Rec. 8-14-15
14	Mill Brook	Sherburne, N. Y.	9.4	Sept., 1905	241	Tr. A. S. C. E. 1914, p. 564
15	E. Fork Honey Creek	New Carlisle, Ohio	11.8	July, 1918	1,290	Eng. News-Rec. 9-22-21
16	Eaton Wash	Los Angeles, Cal.	12.5	1914	367	Los Angeles Flood Control Rep.
17	Arroyo	Near Pueblo, Colo.	15.6	June, 1921	619	Proc. A.S.C.E., Dec., 1921, p. 772
18	Alazan Creek	Near San Antonio, Tex.	16.9	Sept., 1921	1,950	Proc. A.S.C.E., Nov., 1921, p. 454
19	Ridley Creek	Sycamore Mills, Pa.	20.0	Aug., 1843	750	Unpublished data
20	Willow Creek	Heppner, Ore.	20.0	June, 1903	1,800	W. S. P. 96, U. S. G. S.
21	Apache Creek	Near San Antonio, Tex.	22.0	Sept., 1921	704	Proc. A.S.C.E. Nov. 1921, p. 454
22	Cane Creek	Bakersville, N. C.	22.0	May, 1901	1,341	Eng. News 8-7-02
23	Crum Creek	Delaware Co., Pa.	22.0	Aug., 1843	410	Unpublished data
24	River des Peres	St. Louis, Mo.	23.4	Aug., 1915	410	Eng. News 10-14-15
25	Boggs Creek	Near Pueblo, Colo.	25.0	June, 1921	600	Unpublished data
26	Pinal Creek	Globe, Ariz.	25.0	Aug., 1904	560	Tr. A.S.C.E. 1914, p. 564
27	Spring Creek	Piqua, Ohio	27.0	Mar., 1913	210	M. C. D. Tech. Rep. Pt. 4
28	Olmos Creek	Near San Antonio, Tex.	32.4	Sept., 1921	1,000	Proc. A.S.C.E. Nov. 1921, p. 453
29	Olmos Creek	Near San Antonio, Tex.	41.0	Sept., 1921	580	Proc. A.S.C.E. Nov. 1921, p. 453
30	Elkhorn Creek	Keystone, W. Va.	44.0	June, 1901	1,360	Eng. News 8-7-02
31	Olmos Creek	Near San Antonio, Tex.	45.0	Sept., 1921	333	Proc. A.S.C.E. Nov., 1921, p. 453
32	Peck Creek	Near Pueblo, Colo.	46.0	June, 1921	283	Unpublished data
33	Darby Creek	Delaware Co., Pa.	48.0	Aug., 1843	580	Unpublished data
34	Lost Creek	Troy, Ohio	52.0	Mar., 1913	571	M. C. D. Tech. Rep. Pt. 4
35	Tawawa Creek	Sidney, Ohio	54.0	Mar., 1913	239	M. C. D. Tech. Rep. Pt. 4
36	Chester Creek	Bridgewater, Pa.	62.0	Aug., 1843	1,000	Unpublished data
37	Ludlow Creek	Ludlow Falls, Ohio	65.0	Mar., 1913	266	M. C. D. Tech. Rep. Pt. 4
38	Rock Creek	Near Pueblo, Colo.	67.0	June, 1921	348	Unpublished data
39	Dry Creek	Near Pueblo, Colo.	71.0	June, 1921	225	Unpublished data
40	Sweetwater River	California	100.0	Jan., 1916	330	Eng. Rec. 2-19-16
41	Devil's Creek	Viele, Iowa	143.0	June, 1905	650	Rec'd. estimate

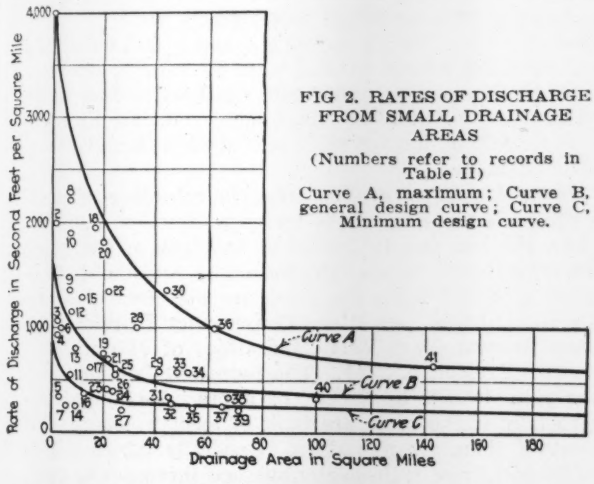


FIG 2. RATES OF DISCHARGE FROM SMALL DRAINAGE AREAS

(Numbers refer to records in Table II)

Curve A, maximum; Curve B, general design curve; Curve C, Minimum design curve.

Rates for Designing Bridge Waterways—It is manifestly impracticable to design bridge openings for the runoff rates indicated by Curve A, except in rare instances where the channel cross-section is unusually large, or where the damage which would result from the failure of the structure would be so great as to warrant the unusual cost. The proportion of the maximum possible rate which should be used in design varies with the relative cost of the structure, the extent of the damage in case of failure, and the size of the drainage area. Other things being equal, the larger the drainage area the larger the proportion of the maximum possible flood rate to be considered. The reason for this is that while the maximum flood of a thousand years is not more than a third or a half larger than the maximum of a hundred years in the case of the larger drainage areas (see Miami Conservancy District's Technical Report, Part V, page 273), it may, in the case of the extremely small areas, be several times as great.

Curve B on Fig. 2 indicates the rates of discharge which it would be well to design for whenever it is financially possible to do so. Curve C indicates the minimum rates to be used.

1913 Flood A Safe Datum—For drainage areas of from 200 to 5,000 sq.mi. in the northeastern section of the United States it is believed that the maximum rates of runoff which occurred in the Miami valley during the great flood of March, 1913, represent about the maximum that will occur on areas of similar size about once in a hundred years (see Miami Conservancy District Technical Reports, Part IV, Calculation of Flow in Open Channels, p. 61). If bridge waterways are designed for such rates, using reasonable factors of safety, it is doubtful if the structures will ever be seriously damaged by floods. Slightly higher rates might be used in the lower Mississippi Valley and southeastern United States, and slightly lower rates in the areas extending northwest from the Ohio River valley.

The rates which occurred near Pueblo last June are indicative of what may be expected at long intervals of time in that part of the United States. Careful hydrographic surveys made by the writer for the Morgan Engineering Co. shortly after the flood showed the following flood discharges on the main streams. The rates determined for the smaller streams are given in Table 2.

Stream and Location	Drainage Area, Sq.mi.	Max. Flow, Sec.-ft.	Max. Runoff, Sec.-ft. Per sq.mi.
Arkansas River, Florence to Dry Creek	940	75,500	80
Fountain River at mouth	930	40,000	43

Of course if overflow can occur around the ends of the bridge during the more unusual floods it will not be necessary to provide bridge waterway for the entire amount of the maximum flow. In such cases it will be sufficient to make the waterway the same size as the main channel above and below, keeping the clearance line well above the high-water elevation so as to avoid accumulations of drift.

Scour Velocities—The maximum velocity to be allowed

through the bridge will vary with the length of time the flood continues, with the depth and character of the foundations, and with the conditions of flow in the approach channel. If the channel is straight, if the piers are parallel to the thread of the current, and if the footings extend well below the bed of the stream and rest on piles or rock, a mean velocity as high as 10 ft. per sec. may be permissible for a short time, even where the river bed consists of gravel. The Miami Conservancy District based its designs on a velocity of 10 ft. per sec. where the river bed is composed of gravel, although observations showed that 6 ft. per sec. caused considerable scour. Wherever velocities higher than 10 ft. per sec. will occur the bridge foundations were protected by a line of steel sheet-piling across the river just below the piers.

The actual velocity that will occur through the opening may sometimes be greater than what would be considered the maximum allowable velocity. In such cases the bridge foundations must be protected against the velocities to be expected. Such cases would be where the slope of the stream above the bridge is so steep that the velocity is greater than is desirable. Simply enlarging the opening will not bring about the necessary reduction: the high velocities will continue through the central spans, leaving dead water or cross current areas in the enlarged portions at the ends. In order to decrease the velocity at the bridge site it is necessary to enlarge the channel for some distance upstream as well as at the bridge. Of course such channel enlargements are not feasible in ordinary highway or railroad bridge work.

What Determines Scour—The amount of scour that will take place is not dependent entirely on the mean velocity of the water. The direction of the current also has an important effect. If the current is directed against the pier the scour will be greater than where the current is parallel to the pier even though the mean velocity is the same. Of course what happens is that where the current is deflected by the pier the velocities at the pier are higher than where the currents are parallel to the pier. The partial collapse of the Third St. Bridge in Dayton about a year ago was due to scour caused by deflected currents in which the mean velocity did not exceed 6 ft. per sec. The same bridge safely withstood the great flood of 1913, when the mean velocity was about 10 ft. per sec. but was parallel to the piers. This illustrates the importance of proper alignment of piers with respect to the channel of approach.

Observations in a small cut-off channel in the Miami River at Dayton a few years ago showed that in a gravel section no scour at all took place when the mean velocity was 5.5 ft. per sec., while in a clay section just below, where the velocity was the same, considerable scouring was going on. A few days later, when a small rise in the river increased the mean velocity to 6 ft. per sec., extensive scour occurred in both sections. Of course the bottom velocities were considerably lower than the mean velocities. The channel was comparatively shallow, being only 2 to 3 ft. deep (see Miami Conservancy District Technical Reports, Part IV, Calculation of Flow in Open Channels, p. 102). Careful hydrographic surveys made in the Miami Valley immediately after the 1913 flood showed that velocities as high as 10 ft. per sec. occurred in several places without causing serious damage.

Scour Protection—Velocities greater than 10 ft. per sec. may be allowed if the river bed through the opening, and just above and below, is protected against scour. It must be remembered, however, that when the velocity through the opening is greater that the velocity of approach, there must be a drop in the water surface just above the bridge sufficient to create the necessary increase in velocity. The writer recalls one instance where a so-called hydraulic engineer, retained by a trunk-line railroad, figured on lining the channel under a bridge with concrete so that a velocity of 20 ft. per sec. could be allowed, without figuring on any drop-off whatever to produce the high velocity. Since the velocity of approach for a bank-full stage was only about 5 ft. per sec., his plans, if carried out, would have meant a backing up of about 5 ft., enough to have flooded several hundred acres of very valuable farm lands.

Effect of Ponding—The principal effect of pondage above a bridge, as far as the design of the waterway is concerned, is to increase the velocity through the opening. Of course there is some reduction in the rate of flow, since the principles involved are the same as in a flood-detention reservoir. However, the detention effect is seldom important. Cases where it might be appreciable would be where the watershed is exceptionally small and the backing up comparatively great. Ordinarily the only consideration which need be given to ponding is to determine how high the water can back up without overflowing valuable property and what such an elevation means in the way of velocity increase through the opening. Railroad engineers seldom figure on any backing up at all, since such conditions probably would result in damage suits even though there were no actual damage.

Retarding Effect of Bridges—The retarding effect of a bridge is made up of the increased friction along the piers, the loss due to impact at the ends of the piers, the reduction in area of the waterway, and the disturbances produced when the piers are not parallel to the direction of flow (see Miami Conservancy District Technical Reports, Part VIII, Hydraulics of Miami Flood Control Project, p. 274). The increased friction along the piers is not, as a rule, of appreciable magnitude, especially if the piers are built of smooth concrete, as most of them are nowadays. Generally 0.2 to 0.3 ft. additional drop in the water surface through the opening will be sufficient to overcome this retarding influence. However, the fact that it exists should be kept in mind and the piers designed so as to reduce it to as small a value as possible. Piers of cellular or columnar structure are less desirable from a hydraulic standpoint than smooth continuous concrete piers.

End Effect—The losses due to impact at the ends of the piers can be reduced to negligible quantities by rounding the ends with smooth curves of not too small radii. Circular or elliptical curves are satisfactory. The ends should never be square. Angles should be avoided whenever possible. Triangular ends are better than square ends, but cause greater retarding effects than where curves are used. Losses occur at the downstream ends as well as at the upstream ends, as is shown by the boils and eddies which can be seen below the piers during any flood.

The heading up caused by a reduction in the area of the waterway has already been mentioned. However, it should be pointed out that not all of this head is lost.

The greater part of it is regained below the bridge, where the velocity decreases to its orginal value, the liberated velocity head being used in overcoming the ordinary channel friction.

It is desirable, whenever possible, to make the area of the waterway under the bridge the same as the area of the channel above and below, even though some heading up can occur without flooding valuable property and without causing undesirable velocities. In such cases the fact that backing up can occur constitutes an additional factor of safety against damage by unusual floods.

Pier Alignment—The alignment of the piers with respect to the thread of the current is one of the most important matters to be considered in working out the details of design. The ideal condition, naturally, is where the sides of the piers are exactly parallel with the currents. If not parallel, or practically so, the effective area of the opening is reduced, the piers are more likely to be undermined by scour, and the disturbed and deflected conditions of flow result in an increased loss of head through the bridge.

Data Needed—In order to design a bridge waterway for a given location the following data should be secured:

1. A cross-section of the channel and flood plain along the center of the roadway.
2. One or two typical cross-sections of the main channel a short distance above the bridge site.
3. One or two typical cross-sections of the main channel a short distance below the bridge site.
4. Elevations and locations of top of banks and low-water edges for a short distance above and below the bridge site. These data, together with the cross-sections, should determine the slope of the channel within reasonable limits.
5. Formation of channel and bed, whether clay, loam, sand, gravel, or rock.
6. Elevations of extreme high water and extreme low water at the bridge site.
7. Extent of flooding and damage caused by flooding to different elevations.
8. Photographs of the bridge site and of the channel above and below.
9. The area drained by the stream above the bridge site.
10. The general topography, geology, proportions of timber land and of farm land, and other pertinent facts pertaining to the drainage area.
11. General information regarding other bridges in the immediate vicinity.
12. Any available stream-flow data from gaging stations in that locality.

The survey at the bridge site need not be elaborate or of great precision. Stadia methods are sufficiently accurate. An experienced instrument man with a couple of rodmen can generally secure all the data needed in a day's time. Distances need not be determined closer than to the nearest foot, or elevations closer than to tenths, except on bench marks and turning points.

The area drained by the stream can generally be determined from some available map, especially if the stream is comparatively large. If the stream is small, uncertainties in the extent of the area drained are not particularly important, considering the magnitude of the question as to what rate of discharge should be provided for. It makes no practical difference whether the drainage area is 6.0 or 6.5 sq.mi. when it is necessary to determine by engineering judgment whether to provide for 200 or 2,000 sec.-ft. per square mile. A cursory reconnaissance of the area should furnish the necessary data regarding the topography, geology, and so forth. The Geological Survey maps are of great value in such work and should be consulted whenever they can be secured. Any available stream-flow data will probably be found in the Geological Survey water-supply papers; the designer should have a complete file of the numbers containing such records for his locality.

If no gaging stations have been maintained on the stream in question, in the vicinity of the proposed bridge, the velocities for different stages may be calculated by the Kutter formula, using the cross-sections and other data obtained in the survey. While such calculations are only approximate, they do indicate about what can be expected in the way of velocities.

Having obtained the data outlined above, the designer, considering the various factors involved, can come to some conclusion as to the best design.

Railway Maintenance-of-Way Affects Fuel and Operating Economy

Relations of the maintenance-of-way department to the general policy of fuel conservation on railways were outlined briefly at the recent annual meeting of the International Railway Fuel Association by W. S. Burnett, engineer of maintenance-of-way of the Cleveland, Cincinnati, Chicago & St. Louis Ry. The following abstract of his paper shows the close relation of maintenance work to operating economies.

On this road the maintenance-of-way department handles the coaling stations, but there is not much opportunity at these stations to conserve coal, except to see that tenders are not overloaded, that coal spilled is kept picked up and that all coal is cleaned out of the cars. Men in charge of coaling stations should keep an accurate record of cars unloaded and make daily reports so that the actual fuel consumption can be known and the cost determined. They should keep a sufficient supply of coal in the dock or hoppers so that the breakage of coal will be reduced to a minimum. The cost of operating coal stations should be continuously checked in order that it may be kept at a minimum consistent with good service. Co-operation of the transportation department is required in keeping a plentiful supply on the unloading tracks, so that the bins can be kept filled to capacity and in case of a breakdown of the hoisting apparatus there will be no delay to trains.

Although the maintenance-of-way department is not so interested in fuel conservation as the transportation and mechanical departments, nevertheless by co-operation with these departments considerable saving can be effected. Work in connection with maintenance of tracks and bridges, rail renewals and reballasting in many instances requires slow orders for the safety of trains. These orders mean greater fuel consumption, especially if the speed is restricted below 30 m.p.h. The program of the work should be carefully considered so as to prevent the stopping or slowing up of trains. In laying rail on double-track this can be avoided partly by single-track operation while the work is in progress. On single track the best time between trains should be selected, so that a considerable stretch of track can be laid in a short time and full spiking and bolting can be carried on under traffic. When reballasting, care should be taken not to strip too far ahead of the gravel supply, so as to avoid skeleton track. Track should be in shape for the passage of all scheduled trains during the work period, and if filled with ballast the track should be left in condition for full speed during the night. Where slow orders are placed on bridges for the protection of workmen and not for the safety of the structure, these orders should be maintained during working hours only.

Location and maintenance of signals and switches are important in fuel conservation. Signals should be so located that they can be readily seen from a distance, and if possible at points where tonnage trains can be easily started. Operating conditions to be confronted in the installation of interlocking plants should be given attention.

Power Company Makes Extensive Triangulation Survey

Details of Methods and Instruments Used by Southern California Edison Company in First Season's Work on Large Area Survey—Government Standards Followed

By W. Mussetter
Southern California Edison Co., Big Creek, Cal.

THE Southern California Edison Co. has completed the first season's work on a triangulation control for the San Joaquin River hydro-electric project which, to the writer's knowledge, is the most extensive and accurate control survey ever attempted by a private organization in the United States. The purpose of this survey is to correlate the different units of the project and to furnish starting points for surveys for local engineering work and topography and to control the accuracy of such surveys.

The work was governed by the U. S. Coast and Geodetic Survey's instructions for primary and secondary triangulation. These instructions call for a mean triangle closing error of not more than 3 sec. for primary and 5 sec. for secondary work, a maximum closure of about 8 sec. and 15 sec. for the two grades, and prescribe base lines of an accuracy consistent with these results.

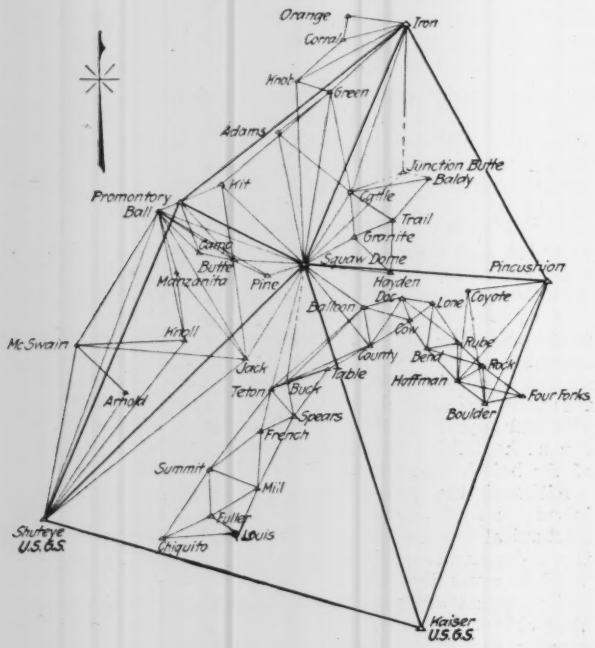


FIG. 1. TRIANGULATION SYSTEM NORTH OF U. S. BASES KAISER-SHUTEYE

The system as completed to date covers approximately 600 square miles of mountainous region in Fresno and Madera counties, Cal. Seventy stations varying in altitude from 2,590 to 10,313 ft. have been permanently marked. The maximum length of line observed is about 15 miles.

In the greater part of the area covered there are no roads of any kind, making necessary the use of pack animals almost exclusively. Several points were reached only after difficult ascents on foot, the building materials, tools and instruments being carried on the backs of the members of the party.

Stations Observed—Main scheme stations were placed in the best locations afforded by topography, consistent with their utility as controls for subsidiary figures, so as to keep the quantity ΣR a minimum. Secondary stations were placed in compromise with the above conditions and conditions of accessibility, proximity to projected work, etc. Following is a summary of the system:

Number of primary stations	14
Number of secondary stations occupied	54
Number of secondary stations unoccupied	2
Number of auxiliary stations occupied	8
Number of intersection stations	2
Total points determined	80

The triangulation was tied into the U. S. Geological Survey triangulation stations Kaiser and Big Shuteye, thereby placing it on the North American Datum.

Scheme, Marks and Signals—The system in general consists of several chains of secondary triangulation, controlled and tied together by a main scheme of primary accuracy. For the main scheme five- and six-sided central point figures were chosen as best fitting the topography and area to be covered. For secondary work quadrilaterals, central point figures, and in a very few instances, single triangles were used. Wherever possible a figure affording double determination of length was employed.

Permanent stations of both classes were marked by a ¾-in. x 6-in. galvanized iron pipe with cap, sulphured in a drill hole in solid rock or a large boulder. In one instance where no rock was available a 1¼-in. pipe 4 ft. long was driven 3 ft. into the ground. A cross on the cap marks the true center. Targets were made of a 1¼-in. galvanized iron pipe-mast bearing at their tops two heavy-gage galvanized-iron vanes set one beneath the other and at 90-deg. angles so as to be visible from any direction. The masts were made in 4-ft. sections for convenience in packing and any desirable number could be coupled together. A 12-ft. mast was standard. Eight-foot masts were used on sharp bald peaks and short lines. Two sizes of vanes, 18 in. x 36 in. and 12 in. x 24 in. were used according to length of time. The vanes were painted red and white by alternate quadrants. Flags were secured in position by three guy wires anchored to eyebolts sulphured in rock, and drawn tight by turnbuckles. The eyebolts were also used as reference marks by recording their azimuth and distance from the station. The targets were readily removed for occupying the station. On a few lines a heliograph was used.

Instruments and Methods—The instruments used were 7-in. Berger repeating theodolites, reading by opposite verniers to 10 sec. directly and to 5 sec. by estimation. The telescope had a 13-in. focal length,

was inverting in type, and was supplied with 29- and 40-power eyepieces. A 6-in. vertical circle, reading to 20 sec. by opposite verniers was fitted to the instrument and was used for trigonometric levels and for time observations. The vernier frame carried a bubble of 10-sec. sensitiveness per 0.1-in. division. A striding level of 8.5-sec. sensitiveness was applied to the telescope trunnions whenever the altitude (+ or —) of a signal was greater than 10 deg. Fixed microscopes were applied to all verniers and electric illuminating provided for night work. A three-screw base was used. Besides its inherent advantages for precise work this permitted the use of a heavy framed wooden tripod loaded with rock to be used on all primary stations, adding greatly to the accuracy. On secondary stations the instrument was mounted on its own tripod. In use the theodolite was protected from sun and wind by a hexagonal tent of light canvas supported by a steel frame to avoid use of a center pole. The instrument was packed in two boxes fitted with harness for backpacking.

Six measurements of the horizontal angles were taken direct, followed immediately by six readings of the corresponding explements with telescope reversed. The alidade was always turned in increasing azimuth. The circle was read on the initial, first, third and sixth, direct and sixth reverse readings. The horizon was closed in all cases. For primary work three sets were taken, and on secondary, two sets. The maximum residual from the arithmetical mean of sets permitted

FIG. 3. STATION IS FOREST SERVICE LOOKOUT

and side equations and length equations when such are involved. The main scheme was first adjusted and then held as fixed and the secondary system was fitted to that. A study of the corrections introduced by the adjustment has been made and tabulated below. To the writer's belief the most rigid test of accuracy is the probable error of an angle. The probable error of an angle is computed from Peter's formula:

$$\mu = \frac{1.2533}{\sqrt{N(N-1)}} V$$

where V is the sum of errors without regard to sign and N is the total number of observations. The mean-square error of an angle is given by the formula, m.s.e. $= \sqrt{\frac{\Sigma\Delta^2}{3N}}$ where $\Sigma\Delta^2$ is the sum of the squares of the closing errors of the triangle, and N is the number of triangles. (See table on page 1078 as an indication of the accuracy of the triangulation.)

FIG. 2. CHARACTER OF COUNTRY INCLUDED IN SOUTHERN CALIFORNIA EDISON CO. TRIANGULATION WORK

Base Measure—One base line only was measured, about 1½ miles long, in the vicinity of Shaver Lake. The location was in cut-over timber land, and quite rocky in character. The line was cleared and 2 x 4-in. stakes 4 ft. long were driven 1½ ft. into the ground at 50-m. intervals, with 1 x 4's set halfway between, and at more frequent intervals when needed to keep the tape clear of the ground. Where rock was encountered a frame was nailed to the stake and heavily loaded with rock. A lead strip ½ in. wide was nailed on each 2 x 4 parallel to the base for marking tape ends. A nail was driven horizontally into the intermediate stakes in line both vertically and horizontally with the end stakes to support the middle of the tape. The apparatus used was standard invar base tapes and stretchers borrowed from the Coast and Geodetic Survey. Thermometers were taped to the end of the tape and read after each application. A party of six was employed consisting of a front and a rear contact, a front and a rear stretcher, a man to carry and place the middle of the tape, and a recorder. The tape was given a tension of 15 kg. indicated by a spring balance on the front stretcher, and the tape end transferred to the lead strips by a very fine scratch. The base was measured forward and backward, different tapes being used for the two measurements. The time consumed in measuring was but four hours.

was 3 and 4 sec., respectively. In both classes the maximum horizon closure allowed was one second times the number of angles. If these limits were exceeded more sets were taken. Initial circle settings were made at or near 0 deg. 0 min. 40 sec., 60 deg. 03 min. 50 sec., and 120 deg. 07 min. 20 sec. for 3 sets, and 0 deg. 0 min. 40 sec. and 90 deg. 05 min. 30 sec. for two sets, so as to use different parts of both the circle and verniers.

No attempt was made to set off these placing readings exactly. Very little difficulty was experienced in keeping within the limiting errors. The average time for observing a set was about 10 minutes.

Adjustment and Analysis of Discrepancies—A rigid least-square adjustment was made of all the figures. This adjustment requires the satisfaction of all angle

STATISTICS SHOWING ACCURACY OF TRIANGULATION

PRIMARY SYSTEM

Number of stations	14
Number of triangles	23
Triangles with plus closure	13
Triangles with minus closure	10
Average closure of a triangle	1".64
Maximum closure of a triangle	3".50
Mean square error of an angle	1".06
Average correction to an angle	0".79
Maximum correction to an angle	2".38
Probable error of an observed angle	1".00

SECONDARY SYSTEM

Number of stations	56
Number of triangles closed	93
Triangles with plus closure	50
Triangles with minus closure	43
Average closure of a triangle	4".22
Maximum closure of a triangle	15".97
Mean square error of an angle	3".23
Average correction to an angle	1".65
Maximum correction to an angle	8".50
Probable error of an observed angle	2".06

Inclination corrections were found by running wye levels in both directions over the stakes and applying the correction necessary to reduce the tape length to the horizontal.

A probable error of 4.6 mm., corresponding to one part in 549,000, was obtained. The base was reduced to sea level by the formula, $L = 1 - lh/r$. For the purpose of computing co-ordinates this length has been raised to the 4,000-ft. plane.

The base net of primary accuracy was developed so as to avoid any distance angles less than 30, and to keep ΣR a minimum.

Astronomic Azimuth—Astronomic azimuth observations were taken at station Long Ridge. Time was determined by the method of altitudes of stars near the prime vertical. Four double altitudes each on a star in the east and one in the west were taken both before and after the horizontal observations. The horizontal angle between Polaris and the mark was measured by the same method as horizontal angles, 72 readings being taken. The time of observation and readings of the stride level in direct and reversed position were taken at each pointing on Polaris.

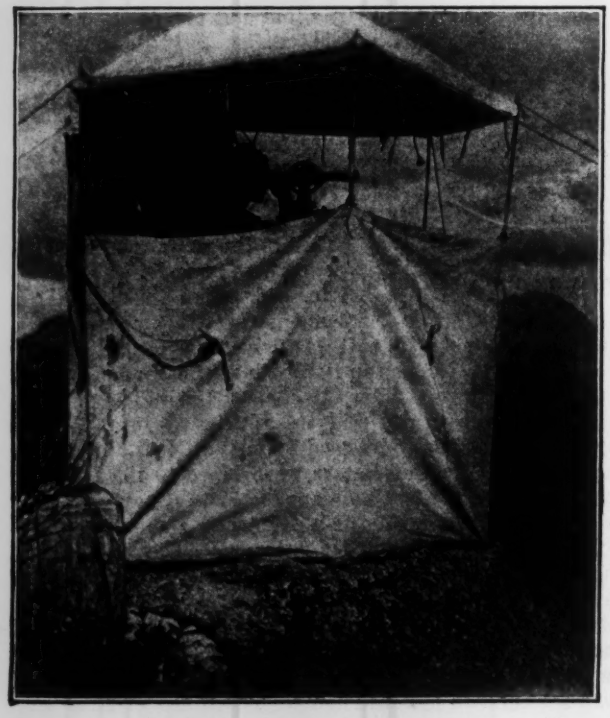


FIG. 5. OBSERVING TENT

FIG. 4. SETTING A STATION

The mark was an ordinary flashlight centered over another station 10 miles distant. This azimuth was tied into a line of the U. S. Geological Survey triangulation, with which it checked to 1.6 sec.

Triogonometric Leveling—Vertical angles were observed at all stations. A double altitude consisted of a pointing direct followed by a pointing in the reverse position. Three double altitudes were taken on each signal. This is the same method as that of double zenith distances, except that the circle was so graduated as to give plus and minus altitudes instead.

The difference in elevation of each pair of stations was computed by the formula: $h_2 - h_1 = s \tan \frac{1}{2}(a - a_2)\,(ABC)$, in which h_1 and h_2 are elevations of the stations, a_1 and a_2 are the measured altitudes corrected for height of instrument and object observed, s is the horizontal sea level distance, and A, B and C are factors for correcting the difference of elevation for mean height above sea level, and for distance on the Clarke spheroid.

The discrepancies in computed elevations indicate the probable error of the trigonometric leveling to be $\pm$ 2 ft.

The entire work, field and office was executed by the engineering department of the Southern California Edison Co. at the head of which is H. W. Dennis. The work was under the immediate supervision of Dr. A. B. Pierce. Twenty-two stations were set and occupied by C. L. Randolph and the remainder, together with the base-line measurement, were placed and occupied by the author.

Plans for 1,170 Miles of Forest Roads

A program of national forest highway construction involving an outlay of approximately $10,000,000 for 1,170 miles of road in 23 states has been approved by the Secretary of Agriculture to be financed largely from the forest highway fund of the Federal Highway Act.

Cast-Iron Pipe Problem and Centrifugally Cast Pipe

Abstract of Committee Report and Papers
Before American Water Works Association

Report of Committee on Specifications for Cast-Iron Pipe

ON the question of specifying the chemical quality of the metal and a definite relation between breaking load and flexure, the outstanding event of the year was the submission to the committee of the report of Dr. Richard Moldenke, who had been employed by the manufacturers to make an extensive investigation. This investigation involved the casting of some 800 test bars at eight different foundries—one-half of which were cast according to the present water-works standard 1x2-in. flat bar, and the other half according to the A. S. T. M. standard 1¼-in. circular "arbitration" bar. All bars were broken transversely and in the case of the round bars one or more of those showing a transverse strength nearest to the average transverse strength were taken for complete chemical analysis and tensile test.

Chemical Tests of Pipe Metal—As to the feasibility of a specification for chemical quality of the metal, Dr. Moldenke finds strongly in the negative, except in the case of sulphur for which he suggests a maximum limit of 0.12 per cent in lieu of the 0.10 per cent recommended by the committee in the tentative revision issued several year ago. His reasons for opposing the specification of chemical quality is that no constituent has an effect which is not dependent upon the amount of other constituents; that the analysis of a test bar may be quite different from the analysis of the same metal when cast in the pipe; and that the final value of the metal is dependent on many other conditions than are disclosed by chemical analysis of a sample taken from the ladle.

Your committee has reached no conclusion in reference to the adoption of specifications of chemical qualities. We are impressed by Dr. Moldenke's argument and also by the expense and time required to make analyses as a day-by-day part of the work of inspection, and it is not improbable that the final decision will be that such specifications, with the exception of sulphur, are impracticable. It is of interest, however, to note that by a very slight widening of the limits set by the chemical specifications included in the tentative revision of the committee, all the bars analyzed by Dr. Moldenke would pass and that, on the other hand, practically all the freak irons which have been found by F. A. McInnes in pipe, broken in use and which he is to describe to this convention [see accompanying abstract.—EDITOR] have analyses which would have thrown them into the discard, if subject to the chemical specifications suggested by the committee.

Relation Between Load and Flexure.—In reference to the specification of a relation between breaking load and flexure in test bars the manufacturers have accepted the principle involved as sound and a reasonable means of checking the possible development of strength at the expense of resiliency. At the first conference with the manufacturers in January it was agreed that the chairman of the New England and American committee should prepare a tentative draft of a revised test bar specification. As submitted to the manufacturers, this draft called for a transverse breaking load of not less than 1,900 lb., a deflection for bars breaking at 1,900 lb. of not less than 0.30 in., and for bars breaking at higher loads a deflection of 0.30 in. plus 0.025 in. for each 200 lb. of load in excess of 1,900 lb. When this specification was applied by Dr. Moldenke to the bars broken by him, it was found that a large percentage would be rejected. As these bars were fairly representative of present practice, this result at once raised questions as to whether a more resilient iron is necessary and as to whether such an iron can be economically produced.

At a meeting with the Foundrymen's Test Bar Committee on April 15, your committee took the position that the revised specifications should lead to the development of the best metal which is economically possible and should not be framed on the assumption that the present irons are as good as can be produced at reasonable cost. It was admitted that the percentage of scrap used—owing to high freight rates and war residues—is now and will be for years to come abnormally high, and while the manufacturers insist that they are making as good pipe as at any time in the history of the industry, it was the judgment of the committee that a further investigation should be undertaken to determine whether a better material than that tested by Dr. Moldenke is economically possible. Accordingly the manufacturers generously undertook to finance further work by Dr. Moldenke and he, in co-operation with W. R. Conard of the joint committee, was authorized to determine by actual variation of the mixture of pig iron and scrap, at one or more foundries, whether an iron which will more nearly meet the tentative specifications for relation between breaking load and flexure can be economically produced. This work is already begun and it is hoped that the report will be available before the end of the year.

One of the interesting recommendations of the Moldenke report is that a new test bar, 20 in. long, with a diameter of 1⅛ in. to be broken between supports 18 in. apart, should be substituted for the present water-works standard 1 x 2-in. flat bar which is broken between supports 24 in. apart. The committee is not convinced that the circular bar is an improvement, but it has subscribed to Dr. Moldenke's recommendation to the manufacturers that parallel tests on the present and suggested type of bars should be carried on for six months.

Improved Coating—In the problem of developing an improved coating no definite progress has been made during the year, and in the absence of any available funds there appears to be little prospect of being able to undertake the work.

Present methods of coating pipe have small regard for the present specifications. The material used is generally crude coal tar, or inferior water gas tar and not a "pitch"—as required by the specifications—except so far as the crude tar is refined to a pitch by the distillation which takes place in the dipping tank. Temperatures are not accurately controlled and overheating, particularly in the case of heavy pipe, is responsible for thin brittle coatings of little value as a protection to the metal.

The manufacturers will furnish just as good a coating as the users of pipe demand, and it is the present feeling of the committee that the most direct road to the development of a better standard is for those engineers and superintendents who appreciate the economy of maintaining the carrying capacity of pipe lines, to adopt a specification which will guarantee the use of a straight-run coal tar pitch and such control of the heating of the pipe and bath as will prevent injury to this material in its application to the pipe. The tentative specifications for tar issued by your committee in 1916 will insure the use of coal tar pitch. [See *Engineering News-Record*, May 31, 1917, p. 449, for tentative specifications—EDITOR.]

Your committee believes that, in view of the possible fundamental effects of certain new processes of making pipe on the problem of standardization, it is perhaps fortunate that we have made progress slowly in reaching any definite revision of existing specifications.

[Reference is apparently made to centrifugal casting, which gives a pipe of high tensile strength and has a bearing on the mooted question of outside diameter. See brief summary of this same committee report, *Engineering News-Record*, May 25, p. 882, also abstract of Prof. Gillespie's paper on centrifugal casting, herewith.—EDITOR.]

The committee is composed of Frank A. Barbour, chairman; Walter Wood, Edward E. Wall, N. F. S. Russell, William C. Hawley, William W. Brush.

* * *

Centrifugally Cast Iron Pipe

BY PETER GILLESPIE
Professor of Civil Engineering, University of Toronto, Canada

THE problem of employing a revolving mould in the process of casting is one that for generations has appealed to the inventor, and it is indeed astonishing that developments along this line have been so long delayed. The history of early attempts to solve it is one marked mostly by failure in which the names of Eckhard, Taylor and Wailes, Huth and others appear. No significant progress in the application of the method to commercial production in the metal industry seems to have been made until quite recently and although it is now employed in the production of articles of non-metallic and non-ferrous composition, it is with the manufacture of cast-iron bell-and-spigot pipe with which this paper is primarily concerned.

The de Lavaud Process—For the manufacture of cast-iron by the de Lavaud process, a plant consisting of a cupola, a revolving water cooled molding machine, an annealing furnace and a dipping vat is required. The molten metal is first transferred from the cupola to a tilting ladle at one end of the machine. This ladle holds slightly more iron than is required for a single pipe of the size to be cast. By an ingenious and perfectly controlled hydraulic device, this ladle can be made to discharge its contents into a cantilevered water cooled trough which projects into the interior of the revolving mold and from the forward end of which iron is permitting to discharge in a stream lying nearly in the plane of revolution.

Revolving Hollow Water-Cooled Mold—The machine includes an accurately made hollow cylindrical mold whose inner dimensions are identical with the outer dimensions of the finished pipe, including the enlarged bell end. This mold is revolved on its axis by an impulse water wheel integral with it, inside a cylindrical stationary casing, the annular space between the two cylinders being filled with cooling water which is continually changing under a moderate pressure maintained at the inlet end. Escape of this water at the ends of the machine between the moving mold and the stationary casing is prevented by the use of gland-like rings somewhat similar to collar thrust bearings employed in marine work. The revolving mold is supported at two points in its length by two sets of friction rollers which have bearings on the inside of the casing and are lubricated by grease cups accessible from the outside. To shape the inside of the bell a single small core is used—the only one employed. This provides an annular shelf for the centering of the spigot and the undercut chase in the bell for the reception of calking lead when the pipes are jointed in service. No bead is provided at the spigot end, this feature being omitted in order that the pipe may be drawn from the mold after solidification of the iron has taken place. The casing and its contained mold are made to travel back and forth on horizontal ways by means of a hydraulic cylinder installed beneath the casing.

Pouring and Spinning—Assume the tilting ladle filled with the necessary quantity of molten iron and the movable casing run forward so that the extremity of the cantilevered trough registers even with the remote end of the mold, which is always the bell end. The turbine is started and when the mold has acquired its proper speed, the tilting ladle is tipped forward discharging its contents into the cantilevered trough. The observer at the bell end signals the first appearance of the molten metal at his end of the pipe whereupon the operator in charge of the hydraulic cylinder immediately starts the backward movement of the casing on its ways. The fluid iron is thus supplied to the mold continuously right out to the spigot end. In contact with the cool revolving mold it solidifies in a few seconds and shrinks from the mold slightly but sufficiently to be withdrawn therefrom by a special hook that engages the spigot end when the casing is again moved on its way in the forward direction. The pipe is then passed directly to the annealing furnace in which case its residual heat is conserved or is allowed to cool in air. The normal output from a machine is 14 6-in. pipes per hour, the operating gang numbering seven men.

Annealing—The process of annealing comes next. The furnace is oil-fired. In it the equivalent of five 6-in. pipes may be treated simultaneously. By a mechanism, these pipes are slowly revolved as the blast plays on them so that all portions are equally heated. This prevents warping and secures uniformity in quality in all parts of the pipe. The temperature is controlled by optical pyrometers.

Comparative Weights—Class C pipe, manufactured for water-works service in accordance with the specifications of the American Water Works Association, has for 4, 6 and 14-in. sizes weights of 23.3, 35.5 and 116.7 lb. per lineal foot respectively. De Lavaud pipes of the same nominal sizes have weights of 15, 24 and 62.5 lb. per lineal foot respectively.

Tests of Pipe Material—The metal in de Lavaud pipe is a fine grained gray iron, uniform in appearance and texture, remarkably free from blowholes and slag pockets and having a wall of thickness surprisingly uniform. From time to time the writer has conducted tests on these pipes and on samples of metal cut therefrom for the purpose of comparison with material cut from sand mold pipes poured from the same heat. In one instance, the two materials when analyzed gave the following results:

Constituent	Machine-Made Pipe Per Cent	Sand Cast Pipe Per Cent
C.	3.45	3.67
Mn.	.49	.61
S.	.053	.044
P.	.563	.654
Si.	2.48	2.00

The tensile strength of the machine-made cast-iron was 37,000 lb. per square inch; that of the sand mold iron was 16,000 lb. per square inch.

The modulus of rupture in cross-bending for the former material was 64,000 lb. per square inch; for the latter, 34,000 lb. per square inch.

The resilience in inch pounds per cubic inch, determined from cross-bending, was 20 for the former and 10 for the latter. The modulus of elasticity, determined also from cross-bending, was 15,400,000 lb. per square inch for the former and 8,600,000 lb. per square inch for the latter. Roughly, therefore, *the strength both in tension and cross-bending, the resistance to shock and the stiffness are about twice as great for machine-made iron as for the sand-cast product.*

In another and more recent series, the tensile strength of the machine-made product averaged 40,000 lb. per square inch; that of sand cast iron, 18,000 lb. The modulus of rupture averaged 59,000 lb for the former and 37,000 lb. for the latter, each item being the average of four determinations. A 6-in. pipe tested by the writer recently sustained an internal hydrostatic pressure of 2,100 lb. per square inch without failure. As the walls were 0.32 in. thick and the internal diameter was 6.25 in. the circumferential tensile stress in the metal shell was practically 20,000 lb. It was the intention to test this pipe to destruction, but the end gaskets gave out at the pressure indicated.

Accurate determinations of the weight per cubic foot showed that the two materials differed but little in this respect. This weight was 433 lb. per cubic foot for each class.

The chilling of the outer layer of metal in pipes made by the de Lavaud process results in the formation there of a thin annulus of white iron. To convert this to a gray iron, the pipes are annealed, as stated above. The molecular

structure after annealing is however different from that of sand-cast iron. The graphite is more finely divided than in the latter where large flakes of that material are in evidence. In this the explanation of the greater strength of the machine-made material probably lies.

Long Life and Other Possibilities—Further, in the fact that smooth metal rusts more slowly than rough (machine molded pipe is unusually smooth, especially on its outer surface), an indication as to long life may be found. Recent researches in the field of electro-chemistry have established pretty well the principle that a metal which is homogeneous in its structure and properties is not likely to develop those differences of electric potential that make for corrosion in service. May not, therefore, the homogeneous structure characteristic of de Lavaud metal be also an indication of its capacity to resist well common influences tending toward corrosion?

The de Lavaud process is one that has great possibilities for usefulness and economy. To the manufacturer it means less metal, less labor, and less foundry space since areas for storage and mixing of sand and for flasks are not required. Moreover the number of rejections at the point of inspection is remarkably low. These circumstances favor an increased output. To the shipper and the customer the lessened weight is an important consideration. The user finds the absence of imbedded sand grains a matter of much importance when he comes to machine the metal, which he finds of uniform texture, free from blowholes, easily worked, and capable of taking a clean steel-like thread when tapped for house connections. To him also the smooth interior and greater cross-section of bore for a given outside diameter are circumstances of some account, favoring increased carrying capacity. All in all the development marks a significant advance in the replacement of manual labor by the machine so characteristic of the industrial achievements of the present century.

Manufacturing rights for de Lavaud pipe within the British Empire, exclusive of Canada, are held by the Stanton Iron Work, Nottingham, England, one of the largest manufacturers of cast-iron pipe in the world. The rights for the United States of America are held by the United States Cast Iron Pipe & Foundry Co., and those for the Orient, including Japan, China and Siberia, by Tsuda & Co., Osaka, Japan. The Canadian company, the National Iron Corporation of Toronto, is to day supplying its product to users distributed throughout Canada from Halifax on the east to Vancouver on the Pacific Ocean.

* * *

Causes of Failure in Cast-Iron Pipe

By F. A. McInness
Engineer Water Division, Public Works Department, Boston, Mass.

THE quality of the metal put into cast-iron pipe is not sufficiently safeguarded in the standard specifications of the water-works associations. Test bars are required to support center loads of 1,900 lb. in the New England and 2,000 lb. in the American specifications and to show a deflection of 0.3 in. before breaking. Because no direct connection is made between the loading and the deflection, 0.3 in. deflection is not shown in many cases until the load is in excess of 2,000 lb., oftentimes largely in excess. Of 2,183 test bars broken by the Metropolitan Water Board of Massachusetts in the past nine years, 905 or 41.5 per cent showed less than 0.3 in. deflection at 1,900 lb., the range being from 0.18 to 0.43, and about 20 per cent show deflections from 0.18 to 0.24, with 389 or 18 per cent between 0.22 and 0.24. [The figures are given in more detail in the original paper.]

The question naturally arises, "Why not specify the composition of the iron, stating just what percentage of the different elements will be allowed, as is done in the manufacture of steel?" There are practicable objections to this course based on the differences in ores and coke throughout the country, on the necessarily different composition of thick and thin pipe, on the practical difficulty of making such a provision effective, on the possible undesirability of specifying both physical characteristics and composition of metal, etc. The writer, however, believes that the permissible sulphur content at least should be specified; with this provision, together with a logical relation between flexure and breaking load fixed in the test bar requirement, a long step forward towards uniform and satisfactory iron will have been taken.

Metal Analyses—Analyses of metal from some of the pipe in the Boston water-works that has been found broken or cracked during the past twenty years, and from broken pipe at St. John, N. B., and Hartford, Conn [reported in detail in the original paper] show some "horrible examples." Witness the 48-in. Boston pipe, laid in 1869, on which there were six breaks between Oct. 19 and Dec. 5, 1900, following a 15-lb. increase in working pressure. This pipe showed combined carbon of 0.04 and silicon of 4.05. A 24-in. pipe at Hartford, Conn., which broke in 1921, showed combined carbon of 0.03 and phosphorous of 1.86. Omitting extremes, the remaining analyses, particularly those in which the sulphur is abnormally high, warrant the conclusion that the quality of the iron was a contributing if not a direct factor in the failure of the pipe. As a rule, two specimen pieces taken from different parts of the broken pipe, were submitted for analysis and in no case was a substantially different result obtained from the bell-and-spigot end of the same pipe.

Higher Standard Suggested—Cast-iron pipe is not a homogeneous material; when pig iron and scrap iron are melted and made into water pipe, the resulting cast iron must vary to some extent in its physical characteristics, owing to differences in the material used in the cupola and to the methods employed in moulding, cooling, etc.; the process of manufacture demands a high degree of skill and oversight if the product is to maintain the uniform quality desired. That this condition does not always exist is apparent to those familiar with the output of cast-iron water pipe. There are notable exceptions, but on the whole it would appear that the general standard of manufacture might be raised to the advantage alike of maker and consumer, to the end that a well coated pipe of uniform and sufficient strength, equal at least to the best of the present product, may be absolutely depended upon.

The writer is one of those who believe in cast-iron pipe for water-works distribution and supply systems, recognizing it to be best suited to meet the conditions usually found; and as its friend, advocates the application of more scientific method in its manufacture than now obtains in many cases.

North Carolina Highway Contracts and Costs for March

During the month of March the North Carolina State Highway Commission let contracts for 138.25 miles of highway at a total cost (exclusive of the usual 10 per cent for engineering and contingencies) of $2,322,975. Of this mileage, 32.62 miles were of the standard types of hard surface construction, i.e., plain and re-inforced concrete and various asphaltic types, costing $1,040,800; 53.35 miles were of waterbound and penetration macadam, and two-course gravel construction, costing $902,660; and 52.28 miles were of sand-clay, topsoil, or one-course gravel construction, costing $379,515. The widths of all surfacings were about equally divided between 16 and 18 ft. The average cost per mile of the hard-surface types was $31,907; of the macadam types, $16,920; and sand-clay and topsoil types, $7,259.

The foregoing figures include all necessary clearing, grubbing, draining, overhaul, reinforced-concrete bridges, and all other work incidental to the proper completion of the projects. The total cost of bridges and culverts (included in the above) amounted to $274,145, making an average cost for these structures, per mile of road, of about $1,983.

Pennsylvania R. R. Will Extend Lines to Detroit

Project Now Under Way Includes 20-Mile Cut-Off and Large Terminals—Gravity Yard and Double-Deck Freighthouses

RENEWAL of active construction work on the Detroit extension of the Pennsylvania R.R., including a new line and extensive terminal facilities, is an important feature in railway development which was authorized in May and will cost about $16,000,000. This new extension of the Pennsylvania R.R. System has been proposed for some years, since its Toledo terminal is within sixty miles of a great manufacturing and shipping center at Detroit. Work was commenced shortly before the World War and was resumed when the railways had been returned to private ownership after the war, but owing to unsettled and unfavorable conditions little progress has been made until the recent order for the completion of the work. The line is being built under the name of the Pennsylvania-Detroit R.R.

Since the general route is already traversed by several existing lines it was found economical to utilize these as far as possible by obtaining trackage rights; but a new line will be built for about one-third of the distance. For the past two or three years the Pennsylvania R.R. has been operating passenger trains between Toledo and Detroit over the Père Marquette R.R. and Wabash R.R. by way of Romulus, Mich.

Toledo-Detroit Line—Starting in Toledo at the junction of the Pennsylvania Lines with the Ann Arbor R.R. near Galena St. this latter road will be used to Alexis Junction, 4.37 miles, and will be double-tracked by and at the expense of the former road. From Alexis Junction the Pennsylvania Lines have secured joint trackage and industrial rights on the double-track line of the Père Marquette R.R. to Carleton, a distance of 25.33 miles.

A new 20-mile line now under construction will extend from Carleton to a junction with the double-track line of the Wabash R.R. just west of its bridge over the River Rouge. Ultimately this will be double-track but only a single track will be built this year. The new line will reduce the distance by about 4½ miles as compared with the present route through Romulus, Mich. From this new junction trackage rights have been secured from the Wabash R.R. for about one mile to Delray. Beyond this point both trackage and industrial rights have been obtained from the Wabash and Père Marquette railroads as lessees of the Detroit Union R.R. and the Fort St. Union Depot Co. Thus the Pennsylvania R.R. will have joint use of the passenger terminal at Fort and Third Sts. which is within a half-mile of the city hall.

The Carleton cut-off or new 20-mile line will branch from the Père Marquette R.R. with a light curve and continue as a long tangent to the west end of the Ecorse yard, where a slight angle will be made and the two main tracks will encircle the yard. The one track now being built passes on the north side of the yard. Between Toledo and the Ecorse yard the maximum grade will be 0.3 per cent. On the passenger tracks there will be grades of 1 per cent around the yard and on the approach to the viaduct leading to the Fort St. union station. Grading for the new line and for that part of the Ecorse yard to be built this year will amount to about 350,000 cu.yd. The only important bridges are a double-track reinforced-concrete arch bridge having four 40-ft. spans and the steel bridges over the Ecorse freight yard. The former bridge was partly built in 1918-1919 at which time the substructures for the other bridges were built. All main line junctions and grade crossings will be equipped with interlocking switch and signal plants.

Terminals and Yards—A large terminal freight yard with gravity switching will be built at Ecorse, at the east end of the new line, about 300 acres having been obtained for the site. There will be two hump yards for northbound and southbound service, together with an engine terminal for freight locomotives. The combined capacity of these yards will be about 12,000 cars and the partial development carried out this year will provide for about 1,100 cars. At present only temporary engine facilities will be provided as it is intended to have the freight engines make round trips from Toledo.

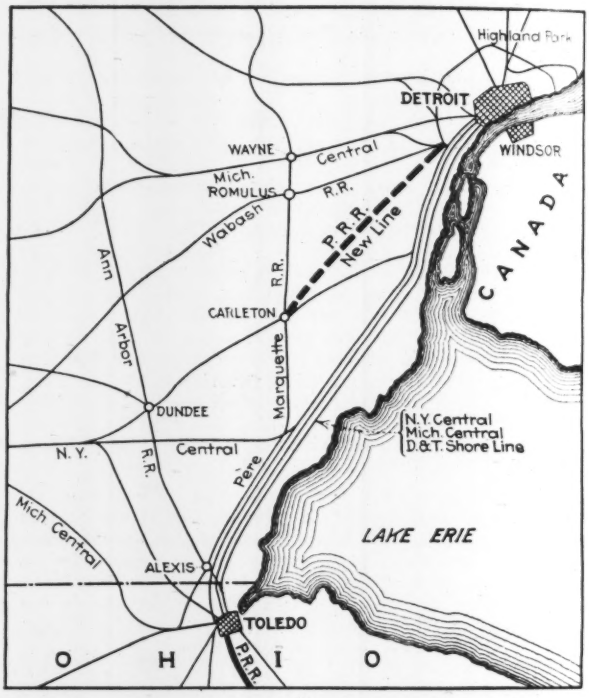


FIG. 1. DETROIT EXTENSION OF PENNSYLVANIA R.R.

An extensive city freight station will be built, the Pennsylvania lines having purchased all the property between Congress, Larned and Third Sts. and Brooklyn Ave. The tracks will branch from the viaduct of the Union Depot line and will enter the second-floor level of the freight station. An inbound freight house 80 x 1,060 ft. fronting on Congress St. will have three storage floors above the track floor. An outbound freight house 60 x 700 ft. will front on Larned St. Between these two buildings and at the upper or track level will be four team tracks with standing capacity for 95 cars, this yard having two driveways reached by an inclined approach from Second St. with a bridge over Third St. This year only the outbound house will be built and will serve temporarily for both inbound

and outbound business. It will be a steel frame structure with brick walls.

A city team-track yard within 2½ miles of the city hall has been provided for by the purchase of ten acres fronting on Fort St. between Summit and McKinistry Sts., extending about 1,000 ft. to the joint tracks. This yard will have a capacity eventually for about 250 cars and it is proposed to build trackage for about 90 cars this year. Passenger equipment will be provided for by a new engine house and coach yard to be built between 12th and 21st Sts. Part of the property to be improved is occupied by the roundhouse and coach yard of the Père Marquette R.R. but the old building will

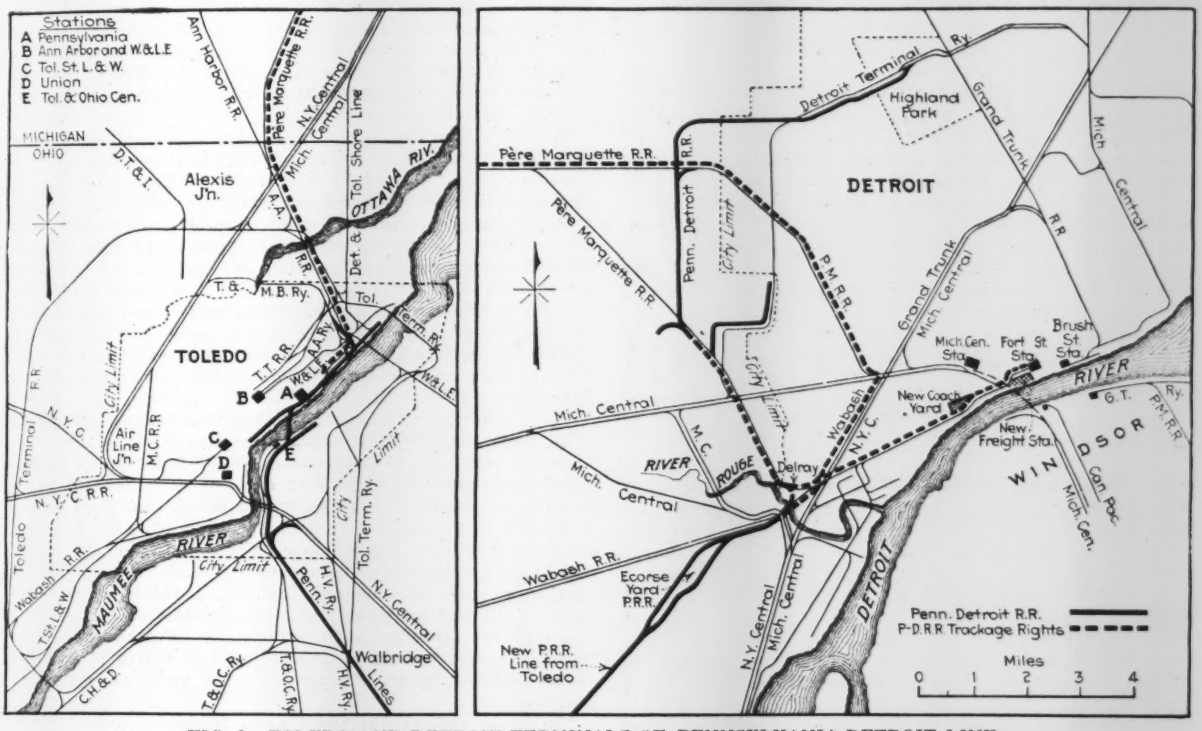


FIG. 2. TOLEDO AND DETROIT TERMINALS OF PENNSYLVANIA-DETROIT LINE

make way for a larger structure for the joint use of the two railroads.

Important industrial connections are included in the project. In addition to those connections along the present tracks from Delray to the passenger terminal the Pennsylvania Lines have secured trackage and industrial rights over all tracks of the Père Marquette and Wabash railroads east of the River Rouge, as indicated by dotted lines in Fig. 2. The Pennsylvania Lines have also constructed the industrial branches shown in solid lines. It is proposed to construct this year the wye connection between the Père Marquette and Wabash railroads just east of the River Rouge and also the extension from the present end of the line around Detroit to Highland Park, thus completing an industrial belt line. Other extensions to be built in the future by and at the expense of the Pennsylvania Lines are required by its agreement with the other two lines and will be subject to joint use by the latter at their option to an extent equal to half the values placed on their respective terminals in Detroit.

Engineer and Contractors—B. V. Somerville is chief engineer of the Pennsylvania-Detroit R.R. (Pennsylvania Lines). Grading on the new line from Carleton is being done by Iliff Brothers, London, Ohio, and the Ferguson & Edmund Son Co., Pittsburgh. The former firm will also complete the concrete arch bridge and the steel bridges will be built by the American Bridge Co

Defective Buildings in Wisconsin Inspected

Recent special inspection of buildings by the Industrial Commission of Wisconsin, which administers the state building code, showed a sufficient amount of defective building to afford a strong argument for competent supervision of building design and construction. In the quarterly report of the state engineer, just issued, the situation is described as follows: "The combination of circumstances including the Knickerbocker Theater disaster and the unusual ice storm in the northern part of the state, resulted in a very large number of requests from various parts of the state for inspection of buildings which were suspected of being unsafe. In most cases the conditions were not alarming. In several instances yielding had taken place because of the load and of construtcion not in accordance with standard practice, chiefly in the case of buildings erected ten to fifteen years ago, before the state building code was in effect. Improper setting of well designed roof trusses, omission of members in trusses, and substitution by contractors who did not understand fully the mechanics of materials, as well as faulty building up of roof supports and floor supports, were some of the defects noted. The conditions emphasize the need for supervision of building design and construction, and the careful checking of plans and field inspection." John G. D. Mack is state chief engineer and R. M. Keown is engineer of the Industrial Commission.

The American Construction Council—Its Field for Service

Vital Need for the Establishment of Aggressive Business Honesty and Co-Ordination of all Elements Voiced in Two Addresses at Washington Organizing Conference, June 19-20

Need of a Vital Code of Ethics in Business

By F. M. Feiker
Vice-President, McGraw-Hill Co., New York City

IN accepting at short notice an invitation to speak before this body I am presenting the views not of one who has been active in the construction industry but of an interpreter and observer over the last fifteen years of a trend in our industrial life which seems highly significant.

There are distinct indications today of forces at work in business life which can re-create the purposes of commerce and set high standards for the conduct of business not only for America but for the world. In hundreds of meetings, across scores of luncheon tables, men are discussing the necessity for a new industrial leadership and the opportunity for that industrial leadership in America. The fine thing about these discussions by thoughtful men is that each sees in his own profession that opportunity for leadership. The lawyer, the engineer, the economist, the statesman, the industrialist, the banker, the manufacturer, the merchant and the salesman—men in all fields of professional and commercial activity, are thinking in new terms of their work, and each in a different way is giving expression to a universal desire. Each is really trying to answer the question, old as civilization, which was phrased by Dean Kimball of Cornell, "What is mine and what is thine?"

Opportunity for Leadership — America above all other nations offers the most fruitful opportunity for a new leadership. Our social structure is not laid up in a stratification of classes. It is still possible for a newspaper publisher to become President of the United States and for a steel-mill hand to head the works. We are, as Americans, idealists. Business to us is an end in itself and not merely a means to an end. The novelist in interpreting the social responsibilities of industry, usually to its disparagement, is prone to overlook this fact. There is something truly American in the possibility that a man, only twenty years old, may come to our shores from Egypt and in ten years become owner of a factory and two retail stores.

The ferment for a new leadership of industry may all be considered from the viewpoint of the professionalizing of commerce. We are, as a nation, strong individualists. As Secretary of Commerce Hoover has put it, we have a very high individual efficiency in industry, but a very low collective efficiency. Creative business men are seeking for new measures of value. Service as a basis for profit-making is coming to be recognized as the true motive for creative industry. Business men are establishing codes of practice in all lines of industrial activity. Men in business are as human as artists or lawyers or chemists, and the ethical standards of men of business are no higher and no lower than the ethical standards of our people as a whole. What is apparent in industry, however, is a conscious effort, a definite attempt to make its standards known, to put commerce on a high plane, and to base creative industry on high ethical principles.

Ethics and Business Conduct—Perhaps the most complete single contribution recording the professional trend of industry, which in a word is the blending of the service motive and the profit motive, is found in the *Annals* of the American Academy of Political and Social Science for May, 1922. Clyde L. King, the editor of this most complete summing up of the status of codes of ethics in the professions and in business, points out in his foreword that codes of ethics are important agencies of social control.

"Until recently," says Dr. King, "business was looked upon solely as a means to a selfish end. The ethics of business were those of the barter market. The buyer could beware. The sole test of the seller was what he could get away with. But modern transportation systems have changed all this. Oranges grown in California must now be marketed in Philadelphia and automobiles are made in Detroit to be sold in the Orient. The manufacturer sells to distant unknown customers through advertising. Even contracts to buy and sell are let by word of mouth. Selling prices must now be announced before goods are produced. Business hangs more and more on good faith. The old adage 'A man's word is as good as his bond' acquires new meaning as a business asset."

Within a few days we have also the testimony of a man recognized as a maker of industrial opinion in this country—Judge Gary of the U. S. Steel Corp. In a commencement address at Northwestern University, Judge Gary said: "It may be asserted with absolute confidence that within the last twenty years or more there has been a decided change in the standards and conduct of business. To my personal knowledge many of the most intelligent managers of business affairs, some very large and others smaller, who have laid down the cares and difficulties of this life, before their final departure completely changed their opinions and reversed their methods concerning ethical questions.

"This applies also to many who are still living. Hundreds upon hundreds, yes, thousands upon thousands of business men, all over this country, who twenty years ago believed that the subject of ethics had little if any rightful place in business conduct, now assert and insist that it is essential and controlling. A man of high intelligence and probity about ten years since, while testifying in court, alluding to a large business concern, said: 'He introduced new rules into the business game.' I think it properly may be claimed multitudes of leading business men during the last two decades have voluntarily devoted more and more time and energy in a conscientious desire to conduct their business in accordance with the rules of propriety and honesty.

"Business throughout the United States is today transacted on a higher plane than ever before, though of course, there is always need for further improvement.

"There is another convincing reason for the noticeable changes resulting from the adoption of ethics in business. While the motives are not equally worthy with others, they are very practical and influential with many who would not otherwise be converted. Ethical management brings additional profits to business. Sooner or later it pays in dollars and cents.

"If by honesty and fair treatment we satisfy our patrons they will show it in all their dealings. They will be less disposed to be hypercritical. They will be reasonable in all their transactions with us and insist upon only what is practical and proper under all existing conditions and circumstances; and if the producer, or one who renders service, professional or otherwise, is assailed by outsiders they will champion his rights. This is of much value in times of stress or of unjust criticism.

Analysis of Code of Ethics—Thus we have stated both from the broad point of view of society as a whole and the practical advantages to those activities of society by which it works and earns—business—the value of codes of ethics as a base.

A consideration of the practical accomplishments of such codes of ethics as have been established can be found in the Proceedings of the American Academy already referred to.

A review of codes of ethics which have been developed

in industry and the professions suggests two broad generalizations as a basis for the development of a code of ethics on the fact of this organization. The first generalization is this:

Develop your code of ethics in such a way that the principles it communicates will be *"seven-day standards of operation and not seventh-day standards,"* and second;

Provide some machinery for their enforcement and review—make them principles of action; not passive platitudes.

Aggressive Honesty Needed—I have had two or three personal experiences in the development of codes of ethics that have brought the truth of both these generalizations home to me. I would suggest the preparation of a code of ethics into two divisions. In the first put the fundamental statements of what constitutes right or wrong in the relations between members of the organization, and in the second, develop ethics in parallel with economics. To state that "honesty is the best policy" is a fundamental; but more essential is it, to make this statement of passive honesty a fighting weapon of truth by shaping it in terms of business practice such for example as who shall receive commissions and on what basis for sales of goods and of services.

It is not fair to the principles of ethics or of economics to assume that a passive policy of honesty will produce business. What we need is policy of aggressive honesty in creative business. Business is a flowing river not a placid lake or stagnant pond.

Take a business of manufacturing and distributing goods. A code of ethics may be established in which the manufacturer agrees that it is wrong to do engineering; the jobber that it is wrong to retail goods. This static ethical agreement might stagnate completely the development of an industry in its service to the public.

If a code of ethics can be devised in which the facts of the numerator are the elements in the industry and the common denominator is the public, the quotient of this fraction will be an aggressive principle of ethics.

Nor does mere statement of an ideal code of ethics suffice. Machinery is needed to put the code into action; to promulgate and develop the truth. I would think it most practical that some system of local non-partisian boards of review be established as the working basis for such an aggressive code of ethics in the great industry which this council represents. Out of such local boards will come the development of principles of accepted business practice grounded on the sound basis of ethics and economics.

Forces to Be Put at Work—To make an aggressive policy the great industrial educational forces of the country need to be put into active co-ordination. There are in my opinion five such great educational forces so constituted and organized that they can be made available:

1. The industrial press.
2. The technical press.
3. The engineering and professional schools.
4. The specialized trade and technical associations.
5. The Government and especially the Department of Commerce.

The Integrity of American Business — Business needs no apologies. American business at heart is sound in the same degree and for the same reasons that the nation itself is sound. Individually, American business men set high standards for themselves in a very practical way. Specifically, if you ask any so-called successful business man what he looks for first in hiring his associates, he will either answer directly in terms of character or picture his specifications in such a way that character is very evidently the thing he is trying to get at. That the essential quality of individual integrity and character is the basis for creative business enterprise is shown by the fact that once a man stumbles in full view of the public, the whole structure of business he may have reared tumbles to the ground because he will no longer be trusted. There are legendary tales of so-called big business men whose "private morals and personal ethics were their own business," but we have had many illustrations of the fact that masterfulness in business can be attained and held only by the sweetness and soundness of personal morality.

It is the collective expression of high ethical standards for the individual which is the foundation for the professional standards of men acting in groups. The structure of business itself rests on credit, which is nothing in the world but a collective appreciation of character.

American industry of the future, with a new vision of service expressed in the practical terms of the professionalizing of industry, is the hope of a reconstructed social and industrial fabric. The United States of America may leave an impression on civilization different in character from that made by any other nation and moving the world forward in a way that no other nation has done. America's expression in civilization must be essentially commercial. We are a commercial nation. But there is nothing cheap in this conception. We have high ideals for commerce We are creators and dreamers. Rome left its imprint on civilization in war; Greece, in art. America can leave its imprint in the new sense of service which finds expressions through commerce and industry.

* * *

Co-Ordinating All the Elements of a Great Industry

By Willis H. Booth
Vice-President, Guaranty Trust Co., New York City

THERE are so many kinds of business which, broadly speaking, enter into the construction industry, and these in turn are affected by so many divergent interests, that it is a really great task to gather them co-operatively together. But the very fact that the component parts of construction are scattered in interest and direction emphasizes the importance of an effort to assemble them so that they may function to good purpose.

Differing from most easily determined industries and, at the same time, touching or comprehending practically all industry, construction has been a hard line of business to get into intense co-operation. It is so widely scattered in its character that it has been obliged by force of circumstance to gather itself into a great many groups, each representing a phase of the business. This was one of the steps in the evolution that has brought us by perfectly normal stages to this meeting this morning. It would be entirely impossible to accomplish what measures up to the ambition of this meeting if we had not previously organized national trade associations of one character and another, which, in the main, comprehend the entire industry.

Obstacles to Complete Accord—I appreciate full well that it is not going to be an easy thing for any council of men, no matter how intelligent or how fair the method of selection, to gather together at any time and be able to guide all of the factors in such a great industry as this. There are so many branches of the business. Construction materials, broadly speaking, are but raw materials; and construction equipment but tools. And then the contractor comes in and, whether it be a building or a bridge, a highway or an ocean liner, by assembling the raw materials and equipment and furnishing labor and executive direction, he produces the ultimate structure. It is only necessary to recite these component parts of raw material, labor, equipment and executive direction to emphasize again their mutual dependency. The executive direction implies the business management of the contractor associated with the highly technical skill of the architect and the engineer. As the matter now stands these component elements are thinking of construction largely in the light of its particular interest to them. This is natural. But in forming this council we appeal to a more enlightened selfishness and feel confident of support on the basis of a more intelligent service to the public. It is this intelligent co-operative service which we hope to demonstrate will be of great practical value to every individual whose contact reaches to the construction field. This council is designed to be primarily a practical thing. The construction industry

in not devoid of vision. No one who builds anything can do so without vision. We know that if this movement can be worked out to its ultimate that the entire standards of construction operation will be bettered and relationship with the public be even greater increased in confidence and respect.

Harmony of All Interests Paramount—But just as we had to reach to the council over the road of trade associations, in the same way this council must reach its ultimate ambition over the road of quietly and gradually developing co-operation between labor, material, equipment and management. In setting up the organization we are only doing a roughing-in job. We are perfectly familiar with the fact that as matters now stand the manufacturer of any of the various materials entering into a job has little or no direct responsibility to the owner. The professional advisers have the aloofness from both the manufacturing and contracting branches which naturally comes from the contrast between professional and commercial standards. The contractor is not a free agent of the owner, but works under the direction of the architect and the engineer. In some cases he is forced to undertake a contract which, while appealing to professional direction, is not mutually advantageous as between the contractor and the owner.

Up to this time there has been no clearing house for these differences of viewpoint. No place where the representatives of each line of effort could sit down and talk the matter over, fully confident that he would be not only accorded a fair hearing, but that he would be properly represented in any decisions that might be reached. Of course, no judgments can be reached except on matters of policy. It is these great matters of policy that make the framework of all our industrial relations.

When we think about policies and want to cast our judgments we must ascertain the facts. And so we find that before we can make a judgment covering a policy in the construction business, or in any other business, we must have before us the statistical information which coupled with our practical experience, gives us the groundwork upon which conclusions may be based. This council, then, naturally becomes a clearing house for the information contained in the industry as a whole. Theoretically this is simple. Practically it is not going to be so easy. But I have every confidence that step by step it will prove its value, will develop the support and co-operation of the component parts of the industry, and ultimately will be so equipped as to have first-hand information on all the elements of vital importance in every phase of the construction business. If this council endeavored to do no more than would be contemplated by this effort, it would, it appears to me, offer every reason for its existence.

Accurate and Full Data Needed—There is nothing more dangerous than half truths. When this council endeavors to compile the statistics of an industry it must be very sure it has gathered every possible bit of information available, and then must give the same out frankly and completely, whether it affects the industry advantageously or not. This is the only way that confidence will be developed, and this council will rise or fall in its effort entirely upon the confidence which is engendered and the value which the public, no less than the component parts of the industry, places upon its observations and recommendations. This statistical information, if properly compiled and gathered as it must be from the trade associations and the departments of the government directly associated with these matters, can be of inestimable value to those manufacturers, especially the smaller ones, whose business it is to provide the supplies for the construction industry. I am fully aware that this situation has been well cared for, particularly in specific lines, but I am advancing the hope that the council will be able to develop itself into a clearing house of statistical information for the whole industry that will be of inestimable value to everyone connected with it.

Development of Business Consciousness—This council, too, representing so completely all of the various phases of industry, should be powerfully instrumental in having the construction business appreciate its own magnitude and importance and its effect upon the prosperity and well being of the nation. This would have the natural result of inspiring at least a portion of those engaged in the business to a kind of dual business patriotism, a patriotism on the one hand which would make them take pride in and be loyal to the business which makes their daily occupation and, on the other hand, be conscious of and loyal to a sense of general public service and public responsibility.

I am not speaking as an altruist, nor dreaming dreams of intangible things. We must learn in this business, if we have not already done so, that all large corporate interests have learned in their specific fields. The old days of figuring that we can operate our businesses without regard to the public have passed away, and the large corporations that are doing the best are those which are working in sympathetic co-operation in the enforcement of laws which recognize the public rights and in operating their businesses in full accord, four-square, with rational public sentiment. Of course this would naturally develop a business consciousness, a sense of obligation, in the wake of which would come more reasonable co-operation throughout the entire business.

At this point the public would come in. The abuses which have beset this industry, as they have beset all other industries, would be gradually cleaned out from within and a permanent set of business morals established which would prevent a repetition of practices which seemed to give temporary advantage, but which, in the long run, are, from a strictly business point of view, unprofitable. In the last analysis the public pays the price. Of that public we are all a part. We like to criticize the other fellow's business but we don't like him to criticize ours. We can't prevent such criticism, no matter how we try, if it is warranted by the facts. The clear common sense of the situation, then, is to put our own house in order to clear ourselves of criticism, and then to criticize the other fellow's business as freely as we wish until he in turn has done exactly the same thing.

Channel Tunnel Again Considered

Another attempt to secure government authority for the long-projected 27-mile railway tunnel under the English Channel was predicted at a recent meeting of the Channel Tunnel Co., in London, at which a number of representatives of foreign governments were present. The project dates back to 1874. At first there were two rival schemes, of which the respective engineers were Sir John Hawkshaw and Francis Brady, but all their bills were rejected by Parliament. The former considered that the tunnel would be secure in the regular chalk formation, but the latter favored a stratum of chalk marl composed of about 80 per cent carbonate of lime and 20 per cent of clay, the clay making the material impervious. Two test headings were driven some years ago, one of which is 7 ft. in diameter and extends 1¼ miles under the sea, at a depth of about 160 ft. There would be a curve in the alignment to keep within this stratum, the terminal points being at Dover and Sangatte, near Calais, about 27 miles apart. Tunnelling machines of different kinds have been tried in this soft rock and the most economical way of handling the muck appears to be its conversion into a slurry or grout which can be pumped. No work has been done in recent years. To insure rapid progress it was proposed to drive a separate pilot tunnel with lateral drifts to a number of working chambers so that the two main single-track tunnels 18½ ft. in diameter could be driven from numerous headings. The pilot tunnel would be utilized for drainage and ventilation. In 1907 the promoters of the two schemes combined on a bill for the Brady project, but this bill also was defeated, mainly for military reasons as in the case of all previous bills. The French drove a short test heading years ago.

Trolley Deck of Manhattan Bridge Converted to Roadway

Highway Traffic Facilities Increased by Removing Abandoned Surface-Car Tracks and Laying Pavement

RAPID increase of vehicular traffic crossing Manhattan Bridge over the East River recently led to the decision to construct an additional roadway on the easterly upper bridge deck. This space had been used by a trolley car line, but as the line ceased operation some time ago the space was available for an additional roadway. The improvement will make it possible to separate the various types of vehicles crossing the bridge, diverting the light, rapid traffic to the new upper-deck roadway and confining the heavy, slow traffic to the main bridge roadway. The work is now about completed.

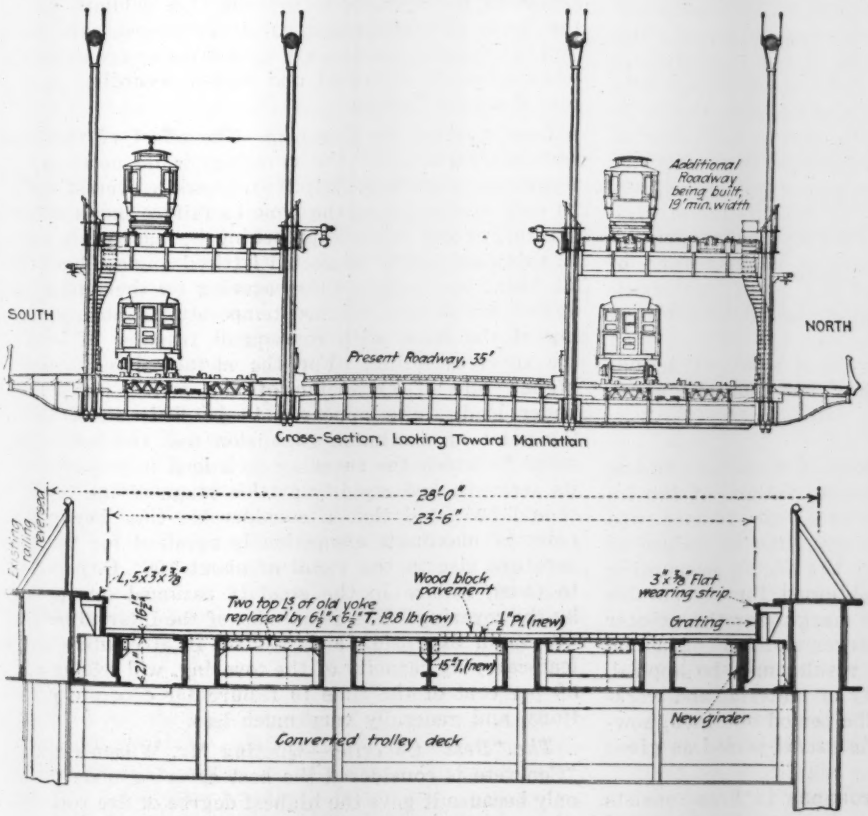
In the original bridge construction each of the two upper deck sections comprised four double lines of stringer girders seated on transverse floorbeams. Trolley car rails were laid on these stringers. The easterly pair of tracks was equipped with slot rails for the cars, which were the subsurface-contact type, while the pair on the westerly deck was equipped with overhead trolley wires. The openings in the flooring were covered with metal gratings.

In the conversion of the easterly upper deck the slot-rail construction was removed and the framing reinforced by a central longitudinal stringer, located in the space formerly between the tracks of the car line. Transverse 6½-in. tees were placed in the former track space, a ½-in. floor-plate was riveted over this framing and a 3-in. wood-block pavement with steel curbing was laid on the plate.

The width of the main roadway is 35 ft. The new upper-deck roadway will for the major portion have a clear width of 23½ ft., while at the anchorages the width will be from 19 ft. to 24 ft. 11 in., at the towers 21 ft. 2 in., at the Manhattan Plaza 25 ft. 8 in., and at the Brooklyn Plaza 25 ft. 7 in. The new roadway will increase the total bridge roadway width 67 per cent, but the carrying capacity will probably be increased in greater ratio because of the separation of slow and rapid vehicles.

The length of the Manhattan Bridge along its center line from Canal St., Manhattan, to Nassau St., Brooklyn, is 6,855 ft.

Grover A. Whalen is commissioner of the Department of Plant and Structures and Edward A. Byrne is chief engineer. These officials planned and are directing the work.



TRAFFIC FACILITIES OF MANHATTAN BRIDGE AND RECONSTRUCTED DECK
Reconstruction will increase roadway width 67 per cent and will allow segregation of slow and rapid vehicles, thereby greatly increasing the carrying capacity of the bridge.

Concrete Pipe Piles in Tasmania

It is reported in the London "Times" that 600 concrete cylinders, constructed by the centrifugal process, are being used in place of timber piles in building a deep-water wharf inside the new breakwater at Burnie, Tasmania. The cylinders are made in 10-ft. lengths, 4 ft. 6 in. in diameter, and the concrete is 12 in. thick. To obtain the requisite height, the cylinders will be placed on top of each other, cemented together, and each joint, completed by an 8-in. steel band. The interior of the cylinder will be filled with sand. The method generally appears to be a variation of the Mouchel cylinder pier system, where reinforced-concrete piles are first driven in clusters to provide a secure foundation, and a hollow cylinder of the same material is built up around the piles, the bottom section having a steel cutting edge and the other sections having spigot and socket joints. The interior of each cylinder is filled up with concrete, binding the whole together to form a solid, continuous pier. One disadvantageous feature of the pipe piling described, according to the "Times," is the doubtful stability of the foundation, and another is the probable lateral weakness of a pier joined in the manner stated, and with nothing better than sand as a central core.

Factors Affecting Fire Resistance of Building Columns

Useful and Ultimate Resistance Periods—Effect of Length—Load Taken by Covering—What Is "Best" Covering?

By S. H. Ingberg

Physicist, Bureau of Standards, Washington

In the interests of sound engineering conclusions concerning the fire resistance of columns in buildings it seems desirable to discuss a little further certain details of the extensive series of tests of full-size columns conducted jointly by the Associated Factory Mutual Fire Insurance Companies, the National Board of Fire Underwriters and the Bureau of Standards, reports upon which were published last year. The following comments refer to the article of R. E. Wilson on the results of these tests, published in *Engineering News-Record* of July 21 and 28, 1921, pp. 106 and 145; to the editorial comment thereon, July 21, p. 91; and to the letter of George E. Strehan, Aug. 18, p. 292.

Information on Fire Action Needed—The editorial comment referred to contains an implied criticism of the report on the tests, on the ground that direct applications of the test results to building construction were not made in the sense of recommending certain types of columns, coverings or covering thicknesses for given building conditions and occupancies. The unit in which the results are expressed, the fire-resistance time period, is a quantitative measure chosen with reference to the most direct application possible, pending the acquisition of more knowledge on intensity and duration of building fires as they affect given structural members. Present knowledge is generally limited to the total duration of fire within the building, or a given portion thereof. Some idea of the severity of the exposure may be obtained, as indicated in the editorial, by comparing effects of actual fires on materials and constructions with those obtaining in fire tests, and perhaps the most reliable source of information at present available is of this nature. However, before dependable generalizations can be made, a greater fund of information must be obtained by more systematic observation of fires and fire effects aided by such experimental research as can be made.

There are a number of errors and misconstructions in Mr. Wilson's article, the more important of which should be corrected.

Ultimate and Useful Resistance—In deriving ultimate resistance periods from the time to failure of the individual columns in the fire tests, the former was taken as two-thirds of the average time to failure of columns within a given group, the factor accounting for variations in the results obtained for comparable columns in the tests, with some margin for the greater range that occurs with the larger number of actual building columns to which the results may be applied, and the greater range in quality of material and workmanship incident therewith. The period obtained, however, is *the ultimate and not the useful period* as given in the article.

The important function of columns in fires consists in supporting the building and preventing general collapse, and the test results are interpreted in terms of this ultimate function. The useful resistance period, within which the column is not damaged to such an extent as to require replacement after the fire, is discussed in the reports ("Fire Tests of Building Columns," Bureau of Standards edition p. 169, Underwriters' edition p. 184), and the apparent close relation for metal columns, between the period of expansion and the useful limit is noted. The method is indicated wherby the useful resistance period can be derived, but the results as finally interpreted, and the values given in Mr. Wilson's table, which is a near copy of Table 46 of the full report, are those pertaining to the ultimate function. This is premised on severe fire exposure, with the quality of material and methods of application somewhat below the average obtaining with the test columns. Under less unfavorable conditions it is recognized (reports p. 202, 216) that the resistance beyond the useful limit may not be developed, but this does not obviate the necessity for distinguishing between ultimate resistance, and useful limit, the difference between which is decided for all but the lower resistance periods.

Effect of Column Length—Limiting the slenderness ratio to 80, as is suggested in the article, is not warranted by the test results, and no decided assurance is had by so doing that a column will come through fires of duration and intensity comparable with its resistance period without permanent deflection of amount requiring replacement of the column. While some of the columns with the higher slenderness ratios attained larger lateral deflections than those of more rigid section, the difference was not general or large. Nothing developed in the tests to indicate that columns within the limit of slenderness ratio considered safe from other structural reasons, are unsafe under fire exposure, when properly protected and loaded according to current design formulas.

Load Carried By Covering—The effect of the load-carrying capacity of the covering, while necessary to recognize (reports p. 201, 216), is easily overestimated. In only one case was the time to failure increased 100 percent, or any figure approaching it, due to this cause. In this case, partly protected latticed angle column No. 22, there was only a thin covering on the lattice and angles, which soon reached temperatures causing yielding of the steel, with consequent transfer of load to the concrete filling. For the metal columns, due to higher rate of expansion of the metal, particularly under load, there appeared to be little effect before the point of maximum expansion was reached, subsequent to which the covering took load in proportion to its strength and rigidity at this stage of the test. It should be noted that a considerable time beyond the point of maximum expansion is required for the temperature rise in the metal of about 100° C. necessary to cause failure in the steel if assumed unsupported by the covering. The remainder of the interval between maximum expansion and failure, if attributed to the load-carrying capacity of the covering, will seldom equal 30 per cent of the time to failure for concrete protections, and generally very much less.

The "Best" Covering—Quoting Mr. Wilson's article: "Concrete is considered the best covering material, not only because it gave the highest degree of fire resistance of any of the coverings tested but also for reasons based on other points of view. The necessary materials

are usually readily obtained, the placing of the covering is subject to lesser variations due to workmanship than in the case of materials not applied integrally, the cost is in most cases appreciably less than of any other material giving the same degree of protection, and concrete covering can usually be readily repaired after moderate fire exposure, whereas with most other materials partial or complete replacement is necessary."

The greater stability of the cast-in-place coverings is conceded, and voids and imperfections can be minimized with proper workmanship. The relative cost is a matter that can be determined only for each particular case. In the case of column protection it is dependent upon a number of related conditions, such as type of floor and partition construction used, and the interior finish to be applied. The relative economy of repair or replacement after fire is equally open to question, and the point can be made that a covering permitting ready removal of damaged portions would have its advantages. It is perhaps best to let the results speak for themselves. The tests show that intelligent selection is necessary in using any material if a given degree of fire resistance is to be attained.

The effect of proportion of mixture on fire resistance was not definitely determined in the tests. The 1:2:4 proportion was generally used, and the periods derived hold strictly only for this mixture. Some decrease in resistance with leaner mix was noted, but not enough to exclude their use if some allowance is made.

Comparing Different Materials—Some other generalizations do not accord with the test results. Unfilled protections of medium semi-fire clay tile are stated in the review to give the same resistance as single-layer of plaster on metal lath, whereas the average time to failure with the former was 1 hr. 45 min. and with the latter 1 hr. 15 min., the respective resistance periods being ¾ hr. and 1 hr. The plaster thickness applied to the test columns, 1 in. and 1⅛ in., are heavier than ordinarily obtaining in building construction. Again, 2-inch solid gypsum coverings are stated to give the same resistance as hollow tile coverings of semi-fire clay and surface clay tile with concrete filling, as against respective average test durations of 2½ hrs. and 3¾ hrs. respectively, and resistance periods of 1½ hr. for 2-inch gypsum, 2 hours for tile with outside wire ties, and 2½ hours for tile with ties imbedded in the joints.

Lastly, quoting the article, "A covering of common clay brick laid flat with brick filling to give a nominal protection of 4 inches in thickness was found to afford a fire resistance equivalent to 2 inches of concrete with aggregates of trap, granite, sandstone, or hard-coal cinders." The time to failure with the brick protection was 7 hours, 13 minutes, and the average for the given concrete protections 4 hours, 7 minutes, the resistance periods being 5 hours for 4-inch brick protection, and 2½ hours for the 2-inch protection of the given type of concrete.

Tests of Small Specimens—Mr. Strehan in his letter refers to certain tests of column protections made by subjecting relatively small areas of the covering material to fire for 2 hours and observing the temperature rise in a metal plate or other construction representing a column on the unexposed side, the acceptance of the material being determined by whether the final temperature in the metal exceeded 550° F. (288° C.). The recent fire tests were made with columns of dimensions in common use under working load in order to bring in the various elements that are concerned in the efficiency of column protection, of which heat insulation is only one. Stability, the ability of the covering material to remain in place, the size of the covered column, interaction of column and covering, unit load applied, and the strength of the metal at given temperatures, enter as related factors. In the case of gypsum, the failure was due to lack of stability caused by shrinkage of the material when exposed to fire, the temperature in the column steel being hardly above 100° C. when the blocks began to fall off (Reports p. 190; 205 and Figs. 127 to 131). That the results should compare in all respects with the heat insulation tests referred to above, or with fire tests of unloaded columns can hardly be expected. In the case of concrete covering, the part of the resistance attributable to the load-carrying property of the covering has already been discussed.

Before the method of applying the coverings was decided upon, a field study was made of methods of placing column protections from which the following conclusions were reached: (1) The coverings are generally applied before the columns receive a large portion of the building dead load; (2) the tile or block protections are set on the structural or lower floor and make fair connection with the floor above; (3) in the case of concrete protections with concrete or a combination concrete and tile floor filling, beams or beam protection, the column covering is continuous with the floor concrete both at top and bottom; (4) with hollow tile or other floor filling, there are likely to be imperfections in concrete column coverings at the floor lines, that can be largely avoided with a little more care or made good by patching with a suitable mortar. Since concrete column protections were most likely to be used with similar floor material, it was decided to place all coverings on the bearing plate at the base, and against or continuous with the head protection at the top, as simulating most nearly the condition likely to hold, and a condition not difficult to obtain even with floor materials other than concrete. Beam brackets were introduced near the top of the columns to simulate conditions and introduce some of the difficulties encountered in placing column coverings in buildings. The load from the ram was applied only to the steel or cast iron section of the head of the column shaft (reports, Fig. 9), the load carried by the covering being transferred to it by the bond and bearing developed in the 3-foot long extension of the column above the furnace chamber. As far as could be ascertained, after test no slip had occurred, and this furnished in part the basis for the statement made in the report (p. 202, 216) in discussing the load-carrying property of concrete coverings, that bond between concrete and a number of forms of metal sections will distribute load to the covering even if the continuity at the floor lines is impaired. That the effect was much smaller generally than Mr. Strehan infers, has already been indicated.

The relatively higher heat insulating value that cinder concrete has developed in some cases has been due largely to the larger amount of water present, which is necessarily introduced in mixing in order to give proper consistency, and which retards the heat flow when the concrete is tested before the excess has been given off. When more fully cured, cinder concrete

does not give as high insulating value as trap rock, sandstone, or limestone concrete. This is shown in tests made with concrete cylinders (Technologic Paper No. 130, Table 1) also in the column tests, in the time required for comparable columns covered with the different kinds of concrete to reach a given critical temperature, as 500° C. (reports, Figs. 150 to 153).

Aggregate Strength No Measure of Concrete Strength

Tests Show That for Texas Materials Compression Value of Concrete Is Independent of Coarse Aggregate

By F. E. Giesecke

Head, Engineering Research Division, University of Texas, Austin, Tex.

IT IS generally believed that the strength of concrete depends partly on the strength of the matrix, partly on the bond between the matrix and the aggregate, and partly on the strength of the aggregate. In order to ascertain the extent to which the strength of concrete is determined by the strength of its coarse aggregate, a series of tests has been undertaken by the Engineering Research Division of the University of Texas. The results of the 28-day and 3-month tests of this series indicate that, for the materials tested, the strength of concrete is almost independent of the strength of its coarse aggregate.

Speaking generally, the coarse aggregates studied in this investigation cover practically the entire range from the hardest to the softest aggregates available in Texas for concrete construction.

The characteristics of the coarse aggregates studied are shown in Table I. The test specimens were 2 x 4-in. cylinders. The aggregates were Colorado River sand, and crushed rock of two sizes, the smaller size passing a ¾-in. mesh sieve and retained on a ⅜-in. mesh sieve; the larger size passing a ½-in. mesh sieve and retained on the ¼-in. mesh sieve.

TABLE I—CHARACTERISTICS OF COARSE AGGREGATES

	Name	Crushing Str. Lb./Sq.In.	Spec. Grav.	Per cent Wear	Hardness	Toughness
A.	Trap Rock	33,600	3.13	1.00	18.34	32
B.	Porphyry	27,800	2.66	1.94	18.9	16
C.	Dolomite	25,500	2.8	2.98	14.65	12
D.	Medium Limestone	19,000	2.62	3.3	11.3	6.5
E.	Medium Limestone	10,300	2.58	4.92	11.34	6.5
F.	Soft Limestone	4,400	2.03	8.72	0	? 0

The aggregates were compounded, by weight, so that one volume of sand was used with every two volumes of crushed rock; the crushed rock was composed, by weight, of one part of the smaller size to two parts of the larger size.

The cement was a blend of Texas cements which passed the standard specifications and had a tensile strength of 282 lb. at seven days and 360 lb. at twenty-eight days. The cement was proportioned so that the richness of the mixes varied from about eight to about fifteen sacks of cement per cubic yard of concrete.

The two principal reasons for using such rich mixes were that the hard rocks are better able to develop a strong concrete in a rich mix than in a lean one, and that aggregates of the small sizes need richer mixes to develop ordinary strengths than larger aggregates.

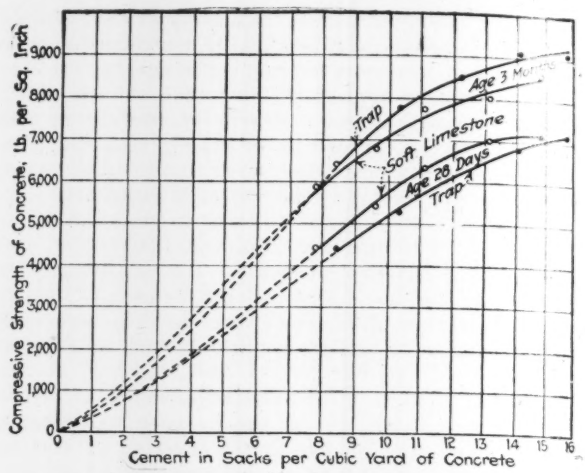


FIG. 1. STRENGTH CURVES FOR TWO AGGREGATES

The total mixing water used was equal, by weight, to 23 per cent of the cement, plus 8 per cent of the sand, plus 4 per cent of the crushed stone. In order to make proper allowance for the difference in the quantity of water absorbed by the different kinds of crushed stone, the following method was used: Immediately before preparing a mix, the crushed stone was immersed in water for 15 minutes and then centrifuged in a Rotarex Extractor for 70 seconds. By this method the crushed stone had no surplus water on the surface and was saturated sufficiently not to extract water from the mix. As well as could be judged by the appearance, the consistency was the same for all mixes.

The series consisted of 300 test specimens: it included six different aggregates and five different proportions of cement for each aggregate, ten specimens were made for each aggregate and each proportion of cement, five to be tested at 28 days and five at 3 months. The five specimens constituting a group were made on five different days in order to avoid accidental variation which might affect the whole group.

The average of the 28-day and 3-months tests are shown in Table II and for two of the materials are given in Fig. 1 and from curves such as these for all the specimens the strengths for mixes of 6, 8, 10, 12, and 14 sacks of cement per cubic yard of concrete were obtained and plotted against the ultimate compressive strength of the coarse aggregate (Fig. 2).

FIG. 2. RELATIVE CONCRETE STRENGTH FOR DIFFERENT AGGREGATES

TABLE II—COMPRESSIVE STRENGTHS OF CONCRETE WITH DIFFERENT AGGREGATES.*

A	(7.81) 5,871	(9.60) 6,828	(11.12) 7,704	(13.15) 8,004	(14.84) 8,536
B	(8.04) 6,307	(9.93) 7,051	(11.70) 7,845	(13.64) 8,135	(15.23) 8,070
C	(8.01) 6,306	(9.87) 7,358	(11.66) 8,116	(13.59) 8,458	(15.21) 8,625
D	(7.99) 5,970	(9.83) 7,189	(11.68) 8,104	(13.47) 8,603	(15.15) 8,721
E	(7.85) 6,003	(9.73) 7,574	(11.55) 8,488	(13.35) 9,035	(14.9) 9,378
F	(8.44) 6,408	(10.36) 7,733	(12.25) 8,467	(14.12) 9,049	(15.80) 9,072

* The figure in the parenthesis is the cement in sacks per cubic yard of concrete. The lower figure is the strength of concrete in pounds per square inch.

It is evident from this figure that, for the materials tested and for the proportions of cement ordinarily

employed in practice, the strength of concrete varies only slightly with the strength of its coarse aggregate. For very rich mixes and high ages the strength of concrete increases slightly with the strength of its coarse aggregate, but for ordinary mixes and an age of 28 days, the strength of concrete made with comparatively weak limestone aggregate is as high or higher than that of similar concrete made with the strong igneous rock aggregates.

The explanation of this remarkable result may be that as the strength of the stone increases, its surfaces become smoother, and, consequently, the bond between the matrix and the aggregate becomes weaker: and that the loss in strength of the concrete due to the weaker bond is about equal to the increase in strength due to the higher strength of the coarse aggregate.

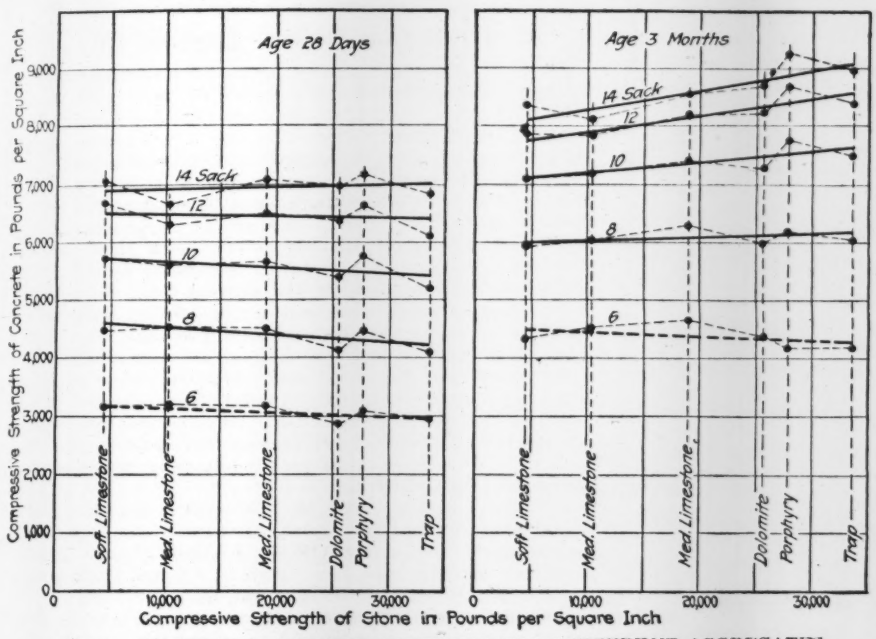


FIG. 2. RELATIVE CONCRETE STRENGTH FOR DIFFERENT AGGREGATES

However, since in this investigation the maximum size of the coarse aggregate was only ½ in., the relative volume of the coarse aggregate was less than it is in ordinary concrete, and it is possible that the strength of the coarse aggregate had a correspondingly smaller influence on the strength of the concrete. This phase of the problem will be studied in another series of tests.

The reader should understand clearly that this investigation relates only to the compressive strength of concrete and not to the resistance to abrasion.

Sewer Pipe Specifications and Alkali Action

A co-operative study of sewer pipe and specifications therefor is to be carried on by the city of Los Angeles, the U. S. Bureau of Standards, and various manufacturers. The object of the study will be to discover whether present standard specifications insure a sufficiently durable pipe for the alkali conditions of that region. A meeting on April 11 formulated a program for the investigation.

Britain Fears Water Shortage

(London Correspondence)

THE water outlook in Britain is again giving rise to anxiety. Although the rainfall for the first five months of this year is above normal in all districts of the British Isles except northern Scotland, the 1921 rainfall rarely exceeded 60 per cent of the average, and was in many parts under 50 per cent, so that the country has begun with a handicap. In London, for instance, the rainfall for the last twelve months has amounted only to 16 in. or about 66 per cent of the average.

The following figures indicate the percentage excess of rainfall in the various districts for the first five months of this year: England, N. E., 14; E., 28; Midlands, 31; S. E., 29; N. W., 5; S. W., 18. Scotland, N., 0; E., 7; W., 15. Ireland, N., 15; S., 3. Channel, 30.

A survey of the national water resources undertaken by the Ministry of Health is being pushed forward as rapidly as possible. Of 1,100 water undertakings over 200 are already suffering from shortage in varying degrees. From the figures available it is shown that it has taken nearly four months' rainfall of this year to make good the 1921 shortage. Thus only the May fall can be counted toward the 1922 supply, and while the early part of the month promised well, the latter part was very dry.

In many parts of Britain the smaller streams have already ceased to flow and the reserves of water in the upper chalks are practically dry. Those districts which draw their water from the lower chalks are better off and can manage at a greatly reduced consumption provided that the fall for the rest of the year is normal—which is unlikely.

It is estimated that the normal amount of water available in England and Wales from underground is 342 U. S. m.g.d., of which 167 is derived from the chalky areas.

The authorities do not intend to be caught unawares this year and conferences of the various experts have taken place. Unfortunately, however, Britain has no reserve supplies of any magnitude to help her out. Among the measures contemplated by the Ministry of Health are: (1) Arrangements for grouping water authorities to pool the available resources. (2) The use of additional sources of supply, including the supplementing of domestic supplies from sources which in normal circumstances would not be used, subject to chlorination under the supervision of officers competent to do such work.

LETTERS TO THE EDITOR

This department aims to be a forum for the discussion of the views of engineers and contractors. The range of interest should be as wide as possible. Contributors are, therefore, asked to make their letters short.

Five-Year Courses at Missouri

Sir—I notice in *Engineering News-Record*, May 25, 1922, p. 888, the news report of the proposed five-year courses for engineers and also your editorial on "Remodeling Engineering Education," on page 894 of the issue of June 1.

Other engagements prevented my attending this conference of deans in Chicago May 19. I was, however, much interested when I received a report of the conference and a copy of the resolutions, to find that the recommendations made as to the plans agreed upon conform closely to what has been in effect at the University of Missouri since 1916.

In regard to the first resolution relating to remodeling the four-year curricula, our curricula in civil, mechanical, electrical, chemical and agricultural engineering were so arranged in 1916 that at least two and one-half years' work is the same for all students, so that the final choice of specialty may be left until the student begins junior year without any loss of time. The five-year curricula are made up so that approximately two-thirds of the time is devoted to technical subjects, the remaining one-third to be chosen from any field of university study under the advice of some one of the engineering faculty. Our four-year courses lead to the degree of Bachelor of Science in Engineering, and the completion of the fifth year entitles the student to the professional degree of mechanical engineer, civil engineer, etc.

Referring to the theme of your editorial, an examination of our curricula will show that what we have already accomplished provides for a larger cultural content in the courses, and gives more attention to engineering fundamentals. It is quite clear that Professor Burr's paper before the Society for the Promotion of Engineering Education last year had no influence in guiding our faculty to their decision, but I have no doubt that the same facts that impressed Professor Burr and led him to the preparation of the paper were, more or less, determining factors with our faculty members when considering the revision of curricula six years ago.

In 1913 a plan was adopted requiring students to have two years' training in arts and sciences before entering the Engineering School. The engineering courses were made three years in length leading to the professional degrees. However, students failed to take advantage of these conditions, and our attendance dropped from over 500 to about 142 in the course of three years. The scheme was abandoned and our present plan adopted. In the new curricula we have included practically the same work that the student was expected to pursue under the other plan in the College of Arts and Sciences, but he is now allowed to enter directly into the School of Engineering as a freshman. It is quite apparent that the student has little discrimination regarding the subject matter presented, but that he objects to the plan of entering for a two-year course in a College of Arts and Sciences to prepare for engineering studies. On the other hand, he offers no objection to spending the same two years in the School of Engineering pursuing practically the same subject matter.

Personally, I am much impressed with the essence of the last paragraph of your editorial, and I believe our plan meets admirably the problem that is there stated. Many men enter engineering courses with intellectual equipment and tastes that debar them from signal success as leaders or in the acquirement of broad culture, but who are of a type indispensable in the prosecution of engineering works, and who must be prepared in some way for carrying on such work. I see no reason why university schools may not by the plan we have already adopted "place emphasis on the training for leadership" while at the same time preparing the less competent for the minor positions in the profession.

I feel that it is due the engineering faculty of the School of Engineering, University of Missouri, that the above facts be made a matter of public record since the actual accomplishment of the curricula revision in 1916 was not brought about without heroic effort on the part of some, and a broadminded outlook on the part of all.

E. J. McCAUSTLAND,
Columbia, Mo., June 9. Dean, Faculty of Engineering,
University of Missouri.

Plain Talk from Another Engineer's Wife

Sir—I realize that your columns should not be used as a forum for disgruntled wives of civil engineers. However, the letter published in your issue of May 25, p. 883, signed "An Engineer's Wife," touches an important question; the claim by unqualified men that they are civil engineers. There can be no doubt but that civil engineers as a body should take decisive steps to eliminate imposters in their profession. This action should be taken not only to protect the dignity of one of the most important of professions but also to safeguard the public welfare.

The apathetic attitude of the general public toward the engineering profession, as well as the lack of understanding of its fundamental principles, is probably largely due to the fact that the average engineer is more interested in achievement than in advertising. My experience has been that many capable engineers suffer from a form of ingrowing modesty, which laudable virtue leaves the masses unimpressed. Wake up, Engineers, and protect your interests! If not for yourselves, for humanity generally and incidentally your families.

Recently I had occasion to talk with a mechanic, who, upon learning that my husband was a civil engineer, patronizingly remarked: "Well, I guess I know pretty nearly everything there is to know about civil engineering, but I had to give the job up; it was too unprofitable." He had acted as chainman on a survey party at one time. This boastful ignorance should be completely and deliberately squashed.

Another pest is the correspondence school "expert." Granted everyone cannot attend an accredited university and obtain one or more degrees; but the competent man can *prove* his ability. Let engineers establish a high standard of requirements for those claiming admission to their ranks. See that this standard is maintained by engineers of known ability passing upon the applicants for admission to the profession before the term "civil engineer" can be used. Back up the necessary examination with actual experience, but don't sell a license as you might for a pet dog.

A high standard of ethics is desirable, but don't be too proud or tolerant to protect it. After all, I am almost inclined to believe that an association of civil engineers wives might not be such a bad bodyguard.

ANOTHER ENGINEER'S WIFE.

Let the Mississippi Overflow

Sir—Your editorial in the May 18 issue entitled "Mississippi Flood Facts Needed," states, "His" (Col. C. McD. Townsend's) "disposition of reservoirs, reforestation, parallel channels, outlets and cutoffs leaves no doubt as to the inadequacy of the only suggested competitors of the levee, which, by elimination at least, justifies the adopted method of control."

When the above "competitors" of the levee have been discussed and rightly turned down, have we exhausted possible alternatives? The writer can not see it that way.

Let us go back to the beginning of levee history. When there were no levees on the Mississippi or its tributaries, the river overflowed its banks to a height of possibly 3 ft. over a wide area of land, anywhere from twenty to a hundred miles in width. It is this annual overflow with its

accompanying deposit of silt that has made one of the most fertile sections of our country.

Then came the beginning of the levee system. Individual planters threw up low levees around their property, (the writer has seen the remains of many of them) 3 to 4 ft. high and representing an almost infinitesimal expenditure compared with the present necessarily high and expensive structures. How high present levees are the writer does not know, but when he left Mississippi River work in 1909, there were many 30-ft. levees with a wide banquette. Comparison of quantities in a 4-ft. levee and a 30-ft. levee with banquette shows the 30-ft. levee to have 5,870 per cent the cross section of the 4-ft. levee.

From the above modest beginning, the independent levee systems were gradually joined together, and levee systems were made on tributaries, the United States got into the game and carried the work along, and at every progressive step, topping was necessary along the entire system. Four-foot levees became 10-ft. levees, 15-ft. levees, 20 and 30 ft. levees successively. Levee taxes were instituted and constantly mounted up. Land held long behind the levee system missed its annual enrichment of silt and became increasingly less rich, and always the flood menace grew.

There are, or at least there were in 1909, many planters on high land outside the levee system, whose lands were subject to an overflow of three to four feet. Did they bewail their lot and move heaven and earth to get a levee between them and the river? They did not. The writer failed to find one of these planters who did not consider himself fortunate in having richer land than his neighbor behind the levee, and in being exempt from the burdensome levee tax.

Does not the answer seem to be to get back, if possible, to the early conditions? Let the individual planter have a low mound for his stock. Let the leveeing be restricted to low levees around towns only, and let the river and its tributaries overflow the land to the full extent that topography permits. The only objection that the writer can see to this solution is that since 1909, the automobile has probably established itself in the valley to a much greater extent than in 1909 and that good roads have spread in consequence. Would not the interruption to automobile traffic and the necessary extra work on roads be a small price to pay for the immense saving of money, the enrichment of the land, and the absence of the menace to life and home gained by letting the river overflow as nature intended?

FRAZER C. HILDER.

Washington, D. C.,
June 10.

Coefficient Curves for Small Venturi Meter

Sir—The accompanying curves of coefficients of a 3.971 x 2 in. Venturi Meter may add some light to the excellent discussion of "Anomalous Results in Venturi Meter Tests," by William J. Walker, in your issue of May 11, p. 797. The Gibson experimental curve given in the article is correct; the other or "orthodox equation" curves never were correct. When a meter shows a falling coefficient with increasing velocities, the writer is sceptical of the experimental work. Errors in the measurement of head are easily made at these low velocities, unless the most precise instruments are used.

If a frictional term be included in the Bernoulli theorem, $m\frac{V_2^n}{2g}$, in which m is constant and n = about 1.75 for smooth pipes, the lost head may be expressed as
smooth pipes, the lost head may be expressed as

$\frac{m V_2^n}{2g V_2^{0.25}}$, and the discharge obtained as follows:

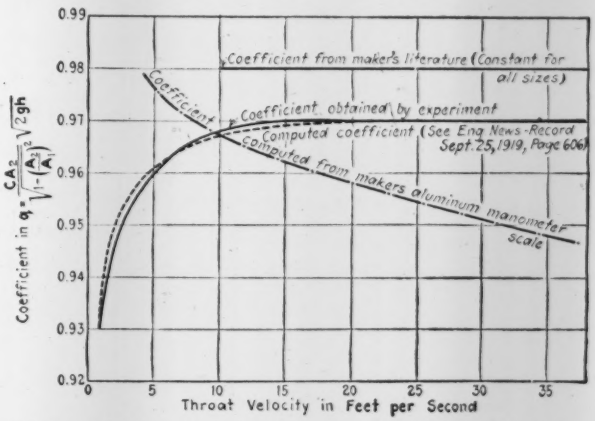
$$g = \frac{A_2}{\sqrt{1-\left(\frac{A_2}{A_1}\right)^2+\frac{m}{V_2^{0.25}}}}\sqrt{2g(h_1-h_2)} =$$

$$\frac{C A_2}{\sqrt{1-\left(\frac{A_2}{A_1}\right)^2}}\sqrt{2g(h_1-h_2)}$$

$$\therefore C = \frac{\sqrt{1-\left(\frac{A_2}{A_1}\right)^2}}{\sqrt{1-\left(\frac{A_2}{A_1}\right)^2+\frac{m}{V_2^{0.25}}}}$$

As long as n is less than 2, C will increase with V_2.

Accurate tests, made by the writer, of more than thirty meters, ranging in size from ⅜ x ⅛ in. to 16 x 8 in., have always given a rising coefficient with increases in velocity.



COEFFICIENTS OF 3.971 IN. x 2 IN. VENTURI METER

Heads were measured as follows: 0 to 2 ft., by a special hook differential gauge reading to 0.001 ft. and interpolating 0.0001; from 2 ft. to 6 ft. on a 1 in. air differential gauge; above 6 ft., on a mercury differential gauge. The discharge was weighed in tanks on scales. The time was taken with a split second stop watch.

W. S. PARDOE,
Professor of Hydraulic Engineering.
University of Pennsylvania,
Philadelphia, May 23.

I. C. C. Holds Tie-Treatment a Betterment

Sir — Referring to the article in *Engineering News-Record*, June 1, 1922, p. 921, Earl Stimson, chief engineer of maintenance, B. & O. R.R., and F. S. Schwinn, chief engineer, International & Great Northern Ry., and also *Engineering News-Record* may be interested to know that the Interstate Commerce Commission has recognized the fact that there is an element of betterment in the chemical treatment of ties.

What is more, any railroad that carries ties in the track at actual cost in the investment account, keeps a record of the original cost of individual ties and credits the investment account with the cost of the individual ties when retired, may capitalize the actual cost of the tie laid in replacement including the cost of treating.

Portland, Maine, June 9. J. N. SUNDERLAND,
Rodboy, Sandy River Railroad Company.

Accident at Vicksburg Waterworks

Two steel smokestacks of the city waterworks plant at Vicksburg, Miss., were blown down during a heavy storm on May 20. Both stacks fell into the clear water basin but without damaging the wall. This was specially fortunate since the flood water of the river was only about a foot below the top of the wall, and even a small break would have resulted in a muddy and contaminated water supply. It is stated by J. A. Steele, Jr., manager of city waterworks, that the 52-ft. steel extension, 3 ft. in diameter, on top of the original 80-ft. brick stack, struck close to the wall and penetrated the ground to a depth of 12 ft.

NEWS OF THE WEEK

New York, June 29, 1922

Civil Engineers Convene at Portsmouth

No Business Transacted, but Nine Technical Papers Presented With Little Discussion

(*Engineering News-Record Staff Report*)

All of the action in this years annual convention of the American Society of Civil Engineers at Portsmouth, N. H., June 19-20, was confined to the meeting of the Board of Direction, reported in last week's issue. The business meeting of the convention lasted about ten minutes, exclusive of formal addresses, and consisted only in announcing the action of the board in appointing Prof. J. H. Dunlap as secretary, electing five honorary members, and establishing the technical divisions. Calls for unfinished or new business brought no response from the floor. A continual downpour of rain prevented any participation in excursions or sports, so that a full afternoon and evening were devoted to the technical papers. On Thursday the weather brightened sufficiently to encourage about 100 of the 200 members and guests to take the excursion to Portland and Casco Bay. The projected White Mountain trip was cancelled on account of bad weather.

PRESIDENT FREEMAN'S ADDRESS

President John R. Freeman divided his presidential address into two sections, the first covering the society and its progress, and the second the progress of hydraulic science, in which Mr. Freeman has specialized in his many years of professional experience. In the first part of his address the president emphasized the greater amount of interest displayed by the directors of the society than at the time of his connection as a director a number of years ago. He said whereas the board then spent an hour or so once a year in the formal acceptance of reports now at least four times a year it has to spend two full days in discussing the numerous matters which are brought before it. He insisted that, contrary to a number of reports, the board is not divided and that in his presidential experience there had been no acrimonious discussion in the board.

He named as hopeful signs of the future the tendency toward more technical work in the society, instancing the formation of the technical divisions just named and the coming activities of the Research Committee. He felt, however, that the society machinery is not sufficiently organized to scan the horizon for technical data and that there was need for more organized support of the local sections and of the student chapters and technical divisions. The monthly publications, he said, are now too much like cold storage warehouses where excellent material is stowed away for occasional future use. He thought that more current matter is

(*Continued on p. 1098*)

To Begin Work Soon on Moffat Tunnel Through Rockies

News dispatches from Denver announce that within a few months work will be begun on the Moffat tunnel through James Peak. This project was authorized by a bill passed at a special session of the state legislature (see *Engineering News-Record*, June, 1, p. 930), under which the counties to be most benefited by the tunnel will form a bonding district to underwrite its cost. The Moffat tunnel has been much discussed since the construction of the Denver & Salt Lake Ry., on which it is expected to improve traffic conditions materially, especially during the winter.

Trains probably will be operated by electricity. The tunnel will be six miles in length, will be at an elevation of about 9,000 ft. and will cost approximately $6,720,000. Two years and a half will be required to complete it, according to estimates.

Highway Tunnel Proposed at Antwerp

Construction of three reinforced-concrete tunnels under the River Scheldt connecting Antwerp with the districts on the east bank of the river is proposed by a Belgian engineer, according to the Engineering Supplement of *The Times*, London. The plan provides for two vehicle tunnels and one railway tunnel, the former to be about 1,300 ft. long and to be equipped with large terminal shafts in which elevators and spiral access inclines can be constructed, while the railway tunnel is to be about 10,000 ft. long.

Drawbridge Wrecked by Steamer

Colliding with the Miramichi River bridge at Newcastle, N. B., the steamer "Canadian Squatter" on June 12 wrecked the bridge, with resulting damage estimated at $60,000. The bridge, was built only a year ago. As the steamer approached the bridge it whistled for the draw, but the draw tender was ashore, and the steamer continued to advance and rammed the bridge. No one was on the structure at the time. River traffic has been interrupted until the debris has been removed and the draw repaired.

Codification of Drainage Laws Begins in Indiana

The Indiana drainage law codification committee has begun work in Indianapolis. Governor McCray appointed the committee by authority of a 1921 statute which provided that the state laws on ditches and drains be codified. Roscoe Kiper, of Boonville, is chairman, and Hyatt L. Frost, Connserville, secretary of the commission. It is not understood that the committee has authority to revise any of the laws on the subject, but they likely will recommend changes to the next general assembly.

Pennsylvania R.R. Announces Plans to Enter Detroit

Details of a $20,000,000 plan whereby the Pennsylvania R.R. will enter Detroit were announced by President Rea before the Board of Commerce of that city on May 25. The project includes a new union station to be built jointly with the Père Marquette and Wabash R.R. in the downtown district and a new belt line around the city that will open up a new industrial area. President Rea announced that the right-of-way for the belt line has already been purchased at a cost of about $8,000,000. Stations and other terminal facilities cost $12,000,000. It is contemplated that construction will be distributed over several years and that about $3,500,000 will be spent this year.

The Pennsylvania plans to use the tracks of the Père Marquette from Toledo to the village of Carleton from which it will build a new doube-track line to the west side of the city. Over the remaining five miles to the heart of the city it will operate jointly with the Père Marquette and the Wabash. New freight depots will be built on West Fort and at Fort St. and 3d Ave.

It is expected that the completion of these improvements will eliminate the costly and time-consuming congestion at Toledo where freight destined for Detroit must now be transferred from the Pennsylvania lines.

Chicago Terminal Facilities for New York Central R.R.

Purchase of the Chicago River & Indiana R. R. (50 miles) and lease of the Chicago Junction Ry. (179 miles) as authorized by a recent decision of the Interstate Commerce Commission will enable the New York Central R. R. to improve greatly its terminal facilities in Chicago. Permission to purchase the Chicago Junction Ry. was refused and the New York Central is required to maintain a separate corporate identity and organization for the combined new properties in order to preserve for shippers the present direct access to the railroad officials.

Both of these properties are neutral lines providing terminal facilities for all the 23 trunk lines entering Chicago, particularly in the stockyards and industrial district. Their acquisition by the New York Central was opposed strongly by several of the other trunk lines and by shippers on the ground of monopoly of terminal facilities and probable discrimination in the handling of competitive traffic. It was opposed also by the Chicago Railway Terminal Commission as an obstacle to the proper solution of the local terminal problem and on the ground that cooperative terminals are far superior to competitive terminals. For these reasons the Interstate Commerce Commission has imposed several restrictions, but the adequacy of these is questioned in the dissenting opinions rendered by individual members of the commission.

Western Society of Engineers Has Big Annual Meeting

The training of engineers was the subject of the principal address delivered by C. S. Richards, formerly dean of the college of engineering, University of Illinois, at the annual meeting and dinner of the Western Society of Engineers, held at the Hamilton Club, Chicago, June 5. Dr. Richards was recently appointed president of Lehigh University. Professional education on a broad basis was advocated, rather than vocational training or the inclusion of a variety of special subjects. At this dinner, attended by more than 200 members, a letter was read from the oldest living member of the society, John E. Blunt, who joined in 1869, was chief engineer of the Chicago & Northwestern Ry. in the "nineties" and retired from active practice in 1906. The society has 2,500 members.

Honorary membership was conferred upon Onward Bates and Capt. Robert W. Hunt, both of whom have long been identified with the active work of the society as well as with engineering progress. Mr. Bates was present but Capt. Hunt was kept away by illness. An annual $150 prize for the best paper on subjects dealing with the iron and steel industry was instituted last year by Capt. Hunt and the first award of this prize is to Gordon Fox for his paper on "Electric Motor Drive in the Steel Industry."

Technical and other activities of the society during the past year were reviewed by the retiring president, C. H. McDowell. The 28 committees aggregating 220 members cover not only technical affairs but also special activities. During the year ended May 31 there were 45 technical meetings, with an average attendance of 145, or 31 per cent higher than in the previous year. There were also seven non-technical or social meetings. Prospective work of the society and the advantages which engineers enjoy by society membership were the subject of remarks by J. L. Hecht, the new president.

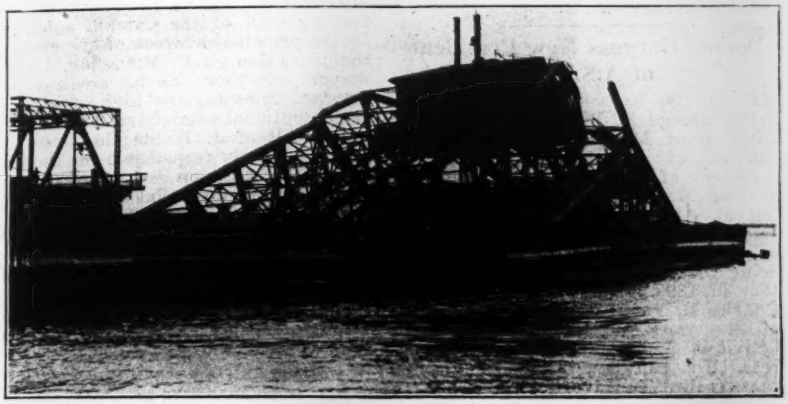
Officers for 1922-1923 have been elected as follows: President, J. L. Hecht; vice-presidents, Frank F. Fowle, Charles A. Morse and E. T. Howson; secretary Edgar S. Nethercut. The several sections have elected the following chairmen: bridge and structural, C. L. Post; electrical, F. E. Goodnow; gas, H. E. Bates, hydraulic, sanitary and municipal, P. E. Green; mechanical, Horace Carpenter; railway, H. G. Clark; telephone, telegraph and radio, Burke Smith.

Revise Quebec's Motor Vehicle Laws

A recent revision of the motor vehicle laws of Quebec, Canada, increases licenses, makes 24,000 lb. the gross weight limit, (16,000 lb. on one axle) and rules vehicles with rated capacities exceeding 2½ tons off the road except in cities and towns. Commercial vehicles, according to the new act, can only be used on roads designated by the Provincial Roads Department.

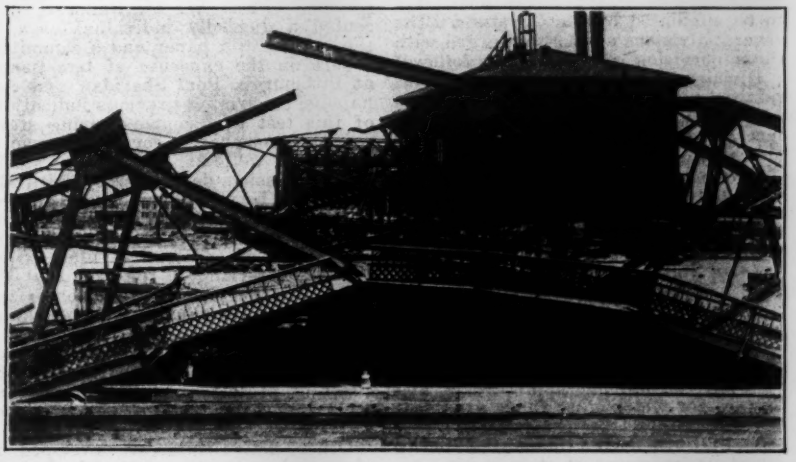
The new license fees provide for payment of 90 cents per horsepower for passenger automobiles with a maximum fee of $80. For motor trucks a differential in favor of pneumatic-tired vehicles has been established, the rates for them being only one-half those for vehicles equipped with solid-rubber tires. For the latter, the scale of fees starts with $50 for trucks with a capacity less than 1 ton and goes upward by $25 increments for each ½ ton to $150 for a 3-ton truck. Trucks exceeding a capacity of 3 tons pay $50 per ton of capacity.

The rates for trucks with pneumatic tires are one-half the above scale except in the case of capacities exceeding 3 tons where the fee is $40 per ton.



Hackensack River Draw Wrecked By Steamer

Upper View, looking southeast (downstream). Vessel ran into far end and pushed draw about 10 ft. upstream. Lower view, looking west from Jersey City rest pier. Top chords broken through just south of center panel. Drum and distributing girders crushed. *Copyright Underwood & Underwood*



Steamer Wrecks Drawbridge on Traffic Artery

Swing Span of Lincoln Highway Structure Over Hackensack River Reduced to Scrap

Running endwise into the fender of the center pier and hitting the end of the draw squarely, a steamer wrecked the steel swing span of the Lincoln Highway bridge over the Hackensack River, between Jersey City and Newark, N. J., on June 22. The span, about 240 ft. long, was so extensively damaged that it is a complete wreck, with probably only scrap value. The views herewith give some idea of the appearance of the wreckage.

There was a strong tide running in at the time the vessel came up the river, and it is believed this had something to do with throwing the vessel off its course. The bridge was fully open, in position directly over the fender piling, which extends up and downstream from the center pier. The vessel, a steel steamer of several thousand tons capacity, hit the end of the fender structure, cut through it and struck the end of the draw, broke the end floorbeam and adjacent floor members, pushed the whole span 8 or 10 ft. longitudinally (northward, or upstream), crumpling up the drum and supporting girders, and caused the upper chords to break in two near the center panel, dropping the two halves of the span down onto the fender piling.

By good fortune the wreckage all remained within the limits of the fender structure, leaving the two channels either side of the center pier entirely unobstructed for navigation. Traffic on the road, however, is interrupted. The Lincoln Highway at this point carries a very heavy commercial traffic, including both local and long distance motor-truck transportation in large volume. The principal trolley connection between Jersey City and Newark also runs along this road. There is only one other road connection between the two cities, the Harrison Turnpike, about a mile north. Plans for a third connection, south of the Lincoln Highway and crossing the head of Newark Bay by a long bridge, have been under consideration for some time by a joint engineering committee representing three counties and the state, but the project for building the new road found little support in the city of Newark.

Ferry service was improvised immediately after the destruction of the bridge, and at the same time plans were developed for providing a temporary crossing, pending the construction of a new draw span. A timber trestle run-around with a single-channel movable span is under discussion. As there is a tidal rise and fall of 4 or 5 ft., it may be difficult to arrange to carry trolley traffic over this structure.

Back Engineer for U. S. Civil Service Commission

The American Association of Engineers is actively supporting A. B. McDaniel, educational specialist and consulting engineer to the General Staff of the War Department, for membership on the U. S. Civil Service Commission. Mr. McDaniel was principal engineer of the Construction Division of the Army during the war. Previous to that time he did consulting work and taught engineering both at Union College and the University of Illinois.

St. Louis Engineers Present Plan for Public Works Board

The Associated Engineering Societies of St. Louis, in conjunction with the St. Louis Chapter of the American Institute of Architects and St. Louis contractors have presented to the Missouri State Constitutional Convention, now in session, a provision for a State Board of Public Works to be included in the new State Constitution. The plan proposes the establishment of a board to be composed of a president and directors of utilities, highways, waterways, and conservation, who shall respectively supervise divisions of structures, utilities, highways, waterways and conservation. Members of the board are to be appointed by the Governor. The several divisions are to be charged with the supervision of activities as follows:

Division of Structures—Lands, natural resources, structures, equipments and improvements in which the state is interested, except as otherwise, provided.

Division of Utilities—Maintenance, equipment, operation and service of all public utilities owned or operated by the State and the assessment of rates and charges therefor, subject to review by the State Public Service Commission, which may be authorized to have jurisdiction over rates and charges of privately owned utilities.

Division of Highways—Construction, reconstruction, maintenance and surveillance of all public highways and bridges for which state funds are used; the director to be chairman of any state highway commission authorized to direct improvement of state roads.

Division of Waterways—Waterways and watersheds within or bounding the State, including nevigable waterways, stream pollution, fisheries, waterworks, irrigation projects, flood control, water power developments, drainage and sanitary matters.

Division of Conservation—Conservation of resources, state planning and public safety.

It is proposed to secure as far as possible the united support of engineers, architects and contractors throughout the state in advocating the provision for the Board of Public Works in the revised constitution.

Award N. Y. Courthouse Contract to Fuller Co., at $4,139,000

Award was made June 23 to the George A. Fuller Co., at an estimated cost of $4,139,000, of the contract for the construction of the New York County Courthouse in New York City. The work includes the entire superstructure, which will be faced with granite, but does not comprise certain plumbing installations, which are to be let under a separate contract. Guy Lowell, architect, designed the structure. The present bid is about $2,000,000 less than bids for the same project opened in 1920.

Doctor Burgess New President of A.S.T.M.

(Engineering News-Record Staff Report)

Dr. George K. Burgess, chief of the Division of Metallurgy of the U. S. Bureau of Standards, was elected president of the American Society for Testing Materials at the annual meeting at Atlantic City, June 27. The meeting, which ends tomorrow, marks a milestone in the society's history, being the twenty-fifth since its formation in 1898. The retiring president, Charles D. Young, reviewed the growth of its work, outlining the present activities and the direction of progress. Dr. Burgess, in turn, suggested that future endeavors of the society should be centered on making its standards more generally applicable, adapting them to service here and abroad. Other officers elected were: Dr. William H. Walker, vice-president; D. M. Buck, W. M. Corse, Dr. W. K. Hatt and J. R. Onderdonk, directors.

Discuss Corrosion

Active discussion of the corrosion of iron and steel featured the opening session. Prof. W. D. Bancroft presented a dicidedly individual view of the subject in a paper and a committee report on the exposure of test panels at Pittsburgh, Port Sheridan and Annapolis, confirming previous indications of this test that copper-bearing steels resist atmospheric corrosion several times as well as low-copper steels. The discussion dealt largely with the distinction between chemical and electrochemical corrosion and with the nature of resistance to corrosion, especially the formation of protective films. Dr. Walker, referring to the fact that the cause for the passivity of iron is not yet known, emphasized the lack of knowledge on corrosion.

Water-pipe corrosion was discussed by F. N. Speller, who described the effect of protective films in pipes and the value of removing oxygen from soft waters.

Other active interest developed in pig- and cast-iron, car wheels and wrought-iron. A new specification for semi-steel and higher-strength figures for malleable iron were adopted. Sharply divergent views of grading pig-iron were expressed. Rawdon and Epstein showed that the nicked break test for wrought-iron is unreliable.

On account of the heavy program duplicate sessions are to be held during two days of the meeting which includes a symposium on impact testing and a discussion of the Joint Committee Report on Reinforced Concrete. Memorial resolutions were passed commemorating the death of the past presidents, H. M. Howe and A. W. Gibbs.

Waldo Smith and Merriman Honored by Associates

Four Hundred Attend Dinner Marking Retirement of Catskill Aqueduct Chief

Four hundred engineers paid tribute to J. Waldo Smith and Thaddeus Merriman at a dinner in the Hotel Pennsylvania, New York City, June 27, on the occasion of Mr. Smith's retirement, after 17 years of service, as chief engineer of the Board of Water Supply of the City of New York and Mr. Merriman's promotion as head of the engineering staff of the Catskill aqueduct. In the principal address of the evening the Hon. George B. McClellan, former mayor of New York, credited the "rugged honesty, the high ideals and the exceptional administrative and technical skill of J. Waldo Smith as the factors directly responsible for the successful completion of the Catskill project without scandal and within the preliminary estimates of time and cost. "His conduct of the work," said Col. McClellan, "was a constant inspiration to his subordinates and a part of his genius lay in his ability to bring together into his engineering organization the same type of American lad that won the war in France."

Merriman an Able Successor

Col. McClellan paid high tribute, also, to Mr. Merriman's share in the enterprise, emphasizing that he had grown up with the work since its inception 17 years ago and was the man best qualified by experience and technical attainments to succeed his former chief. At the conclusion of the former mayor's address mementos in the form of a watch for Mr. Smith and a cigarette case for Mr. Merriman were presented.

The retiring chief engineer accorded to Col. McClellan chief credit for initiating and carrying through the Catskill water supply project, in the face of persistent political interference. "There should be rotation in office in any organization," said Mr. Smith, in referring to his former deputy, "and Mr. Merriman has demonstrated his ability to carry on the work which I now turn over to him. His appointment as chief engineer follows the policy of promotion within the organization for which I have always stood."

The evening's session ended with an appreciation by Mr. Merriman of J. Waldo Smith's distinguished service and a plea for the maintenance within the ranks of the organization of the high ideals established under his predecessor's administration. "Every man must be a debtor to his profession," said Mr. Merriman, "and progress can be made, not through the efforts of a single individual but rather by a striving for better standards in every strata of the great mass of men who constitute the country's engineers."

Col. Merritt H. Smith, chief engineer of the New York Department of Water Supply, Gas and Electricity, acted as toastmaster and the arrangements for the dinner were in the hands of a committee headed by Robert Ridgway, chief engineer of the Transit Commission, as chairman and W. J. Buhrendorf, chief clerk of the Board of Water Supply as secretary. The attendance was thoroughly representative of both engineering and contracting interests in the metropolitan district.

S.P.E.E. Would Broaden Service to Engineering Education

Resolutions adopted by the council of the Society for the Promotion of Engineering Education, at its convention held at Urbana, Ill., June 20 to 23, directed the president, Prof. Charles F. Scott, to appoint a committee of five members, including himself, to study the development of the society and to formulate an answer to the question, "What can the society do in a comprehensive way to develop, broaden, and enrich engineering education?" This committee is to report to the council as soon as possible.

In his presidential address Prof. Scott emphasized the need of the technical industries for engineers competent to serve not only as trained technicians but also as leaders in production and in administration. He pleaded also for more effective means of checking up the effectiveness of present engineering instruction in fitting students to meet these requirements.

Among the papers of general interest were those by W. H. Rayner of the Univ. of Ill. on the "Cultural Element in Engineering Education"; J. Raleigh Nelson on the teaching of English in the engineering course; J. H. Dunlap, of Iowa State Univ., on "Some Problems in Engineering Education"; and Charles E. Chadsey, of Univ. of Ill., on "Teaching."

The Council of the society considered but took no action on 5-year engineering courses recently endorsed by the deans of the mid-west engineering schools. It voted to establish within the society a new section composed of deans and school directors.

The election of officers resulted in the re-election of Prof. Charles F. Scott of Yale University as president. New vice-presidents are D. S. Kimball of Cornell and F. G. Higbie of Iowa. New members of the council are M. W. Alexander, National Industrial Conference Board, Edward Bennett of Wisconsin, H. S. Evans of Colorado, E. A. Hitchcock of Ohio, H. J. Hughes of Harvard, C. E. Magnussen of Washington, and G. C. Shaad of Kansas State.

The convention next year will be held at Ithaca, N. Y.

For Cleveland Improvements

Several prominent movements projected or under discussion in Cleveland have been reported upon by the civic committee of the local chapter of the American Association of Engineers. The river straightening project, under discussion for a number of years, is opposed, and its abandonment is recommended. The plan for a union station on the public square, as proposed by the New York Central R.R., is approved. The river crossing problem is dealt with in a general study relating to a number of the Cuyahoga Valley bridges, as a result of which the Lorain-Huron viaduct project is opposed, the old Superior viaduct is recommended for reconstruction and addition of a branch crossing, vehicle traffic to be divided so that the old viaduct takes heavy trucking and the new Detroit-Superior viaduct carries only passenger automobiles, and construction of a new viaduct on Carnegie Ave. is recommended. The thoroughfare plan of the city planning commission is also approved.

The Engineer in Public Life

MORTIMER Y. FERRIS

Mortimer Y. Ferris, New York State senator from the 33rd District and chairman of the Senate Committee on Agriculture was born in Brookline, Mass., March 29, 1881, and was graduated from the civil engineering course of the Massachusetts Institute of Technology, Boston, in 1903. After a year's work at New Castle, Pa., as assistant in the engineering corps of the Pennsylvania Lines West of Pittsburgh, he moved to Ticonderoga, N. Y., and established an office for the general practice of civil engineering which he has maintained ever since.

He served on the Ticonderoga Board of Education for ten years, the last three years of which he was president. In 1916 and 1917 he was elected village president.

Mr. Ferris was first elected to the New York State Senate in the fall of 1918 and has since continued to represent the 33rd Senatorial District, comprising the counties of Clinton, Essex, Warren and Washington. He has been active in all matters affecting the engineering profession and introduced and was largely responsible for the passage of the recent legislation combining the engineering forces of the state in a single department under the state engineer and surveyor, and for the state registration of professional engineers and land surveyors. He has also been prominent in water-power, stream-regulation and conservation matters.

Federal-Aid Road Appropriations Cover Three Years

Appropriations for state highway construction in the 3-year federal-aid program referred to in *Engineering News-Record* of June 15, p. 1015, should have been stated as follows: $50,000,000 for the fiscal year ending June 30, 1923; $65,000,000 for the year ending June 30, 1924; and $75,000,000 for the year ending June 30, 1925.

Low Municipal Bond Interest Rates

The ruling interest rate for municipal and state bonds continues to be 4½ per cent or less. The yield rate for 21 of 26 issues reported by the New York *Times*, as sold during the week ending June 23 was 4½ or under, with 10 issues of 4½ or less and several at 4.3 and 4.35. The Chicago South Park Commission sold $1,500,000 of 4 per cent 1-20-yr. bonds to yield 3.95 to 4 per cent, while $3,073,000 of Jersey City 1-35-yr. gold school bonds bearing 4½ per cent sold to yield 4 to 4.25 per cent.

Hearing on San Francisco Bay Terminal Plan

Plan Advocated for Reclaiming 170 Acres of Shoal Land Adjoining Goat Island

A special commission composed of one representative each from the departments of war, Commerce and the Navy conducted a hearing in San Francisco on June 12 to give all interested parties an opportunity to present opinions and objections on the application of the San Francisco & Oakland Terminay Ry. for permission to reclaim 170 acres of shoal land adjoining Goat Island and to construct thereon a union terminal for the use of interurban systems, automobiles and transcontinental railroads.

Major General Lansing H. Beach, chief of engineers, U. S. A., was chairman of the hearing, Admiral A. S. Halstead, commander of the Twelfth Naval District, represented the navy and C. H. Huston, assistant secretary commerce, was the third member. Col. Herbert E. Deakyne, San Francisco office, Corps of Engineers U. S. A., served in an advisory capacity.

Review Traffic Situation

J. S. Drum, chairman of the board of the railway company, reviewed the transbay traffic situation and the advantages of the proposed terminal, pointing out that the company was quite willing to have other transportation companies join in the project. Edward M. Boggs, consulting engineer for the company, presented the engineering aspects of the plan. In his opinion bridge or tunnel projects that would supplant the ferry service for commuters was in the far distant future and meantime, at a reasonable cost, the present 18- to 20-min. ferry trip of 2.85 miles could be reduced to a 10-min. trip of about 1.6 miles. Last year the ferries of the Southern Pacific and Key Route systems combined handled 45,000,000 transbay passengers.

Since the greatest item of cost in connection with the proposed union terminal would be the crossing between the east shore and the reclaimed land near Goat Island, the application asks for as much concession on this point as can be granted. A solid fill 20 ft. wide was declared to be the most desirable. Such a fill would not exert any important influence on tidal flow, Mr. Boggs believed, nor interfere seriously with bay traffic since the alternative route around Goat Island is wide and deep and for most all the traffic is little, if any, longer. However, if permission to build a solid fill could not be granted, a combination fill and trestle was suggested. The requirement that the channel be kept open to navigation by the construction of a drawbridge or even a viaduct to allow clearance for comparatively small vessels would make the cost of the plan prohibitive, he thought.

Representatives from other companies and neighboring cities expressed interest in the plan but nothing tangible was raised in the form of objections.

Based on the hearing and the conclusions reached after a firsthand study of local conditions, the committee is to make recommendation to Congress by which body final action on the application must be taken.

Civil Engineers' Convention

(*Concluded from p. 1094*)

needed, more of what is going on in the engineering world, book reviews, pictures of men, and that if it were necessary there could well be twelve or even twenty-six issues a year carrying such features.

In his second section Mr. Freeman traced the history of hydraulic science from the time of the Romans to the present. He feels that we are at a point now where a more thorough and elaborate theoretical study of hydraulics should be made—such things as the control of rivers—and that now is the time to urge and promote a federal hydraulic laboratory.

Papers Many and Various

As reported in the advance program, nine technical papers were on the program. Thanks to the bad weather which would not permit any one to get far from the hotel, it was possible to complete the full program, in a damp and close little movie house, but it was obvious that the makers of the program were somewhat ambitious in their layout because had the projected excursions taken place, there would not have been any possibility whatever of getting through more than a quarter of the technical papers outlined. As it was, the papers were on so many different subjects that the audience apparently was unable to shift its mental attitude from subject to subject sufficiently quickly to start or continue any discussion. The program, therefore, consisted merely in the presentation of the papers. Practically no discussion followed them.

A further report on the well-known Aberthaw tests of concrete piles in sea water was included in a paper by L. C. Wason, president of the Aberthaw Construction Co., and read by a member of his staff. The paper added nothing to the earlier report except to give a few figures of strength tests of the concrete in those few piles which had failed. Col. W. G. Atwood, the director of marine piling investigations of the National Research Council, presented a most absorbing report of the activities of the marine borer which is infesting some Pacific coast waters and which is causing some apprehension in eastern waters. Col. Atwood indicated that the study now was largely a biological one, that protection of structures against the borers was at best temporary, and that the hope of the future lay in some biological attack. He was not able, however, to promise anything at the present time.

Prof. W. K. Hatt, the direction of the Highway Research Committee, Division of Engineering of the National Research Council, reported the various tests on highways now under way in the United States. The report was a longer exposition of the activities which have been recorded in this journal.

Three papers connected with wood pulp were considered together, the first by Prof. George C. Whipple of Harvard University, entitled "Pollution of Streams by Paper Mill Wastes," a study of the bacteriological conditions in waters downstream from paper mills; the second by H. W. Clark, chief chemist of the Massachusetts State Board of Health, on the same subject from a chemical standpoint; and the third by E. B. Wardle, chief engineer of the Laurentide Co. of Canada, on the wood pulp industry in general. Mr. Wardle's paper was presented mainly as a set of still and moving pictures.

Two papers on the Quebec stream regulation were read, one by O. Lefebre, chief engineer of the Quebec Streams Commission, on the problems in connection with the St. Maurice river regulation, a subject which has been discussed in this journal, and the other by J. H. Brace of the contracting firm of Fraser, Brace & Co., on the Gouin Dam which was built five years ago on that river.

In the evening Frank W. Hodgdon, chief engineer of the Division of Waterways of the Massachusetts Department of Public Works, showed a number of views of the minor shore protection work undertaken by the State of Massachusetts along the Atlantic Coast, and in a formal discussion Henry S. Adams of Boston showed the condition of failure of a number of old cribworks in the northeastern Atlantic Coast, Frederic H. Fay outlined the new development of the port of Portland, and Lt. Col. Wildurr Willing gave a formal statement of the amount of work done by the federal government in New England harbors. The last paper of the evening was an illustrated talk by J. W. Rollins of Holbrook, Cabot & Rollins Corp. on the foundation work at the Piscataqua bridge at Portsmouth, where pneumatic caissons were sunk in 80 ft. of water in a tide rip between the islands of the harbor.

Engineering Societies

Calendar

Annual Meetings

AMERICAN SOCIETY FOR TESTING MATERIALS, Philadelphia; Annual Meeting, Atlantic City, N. J., June 26-30.

NEW ENGLAND WATER WORKS ASSOCIATION, Boston; Annual Convention, New Bedford, Mass., Sept. 12-15.

Personal Notes

WARREN C. EARLE, who has been consulting engineer for the city of San Diego, Cal., has taken the position of city engineer of Pasadena, Cal.

LEROY F. WERTZ, assistant chief engineer of maintenance of the Indiana State Highway Department, has been named chief of the division of auditing to succeed John D. Williams, who recently was made director of the state highway commission. Mr. Wertz has been in the department for about a year. He is a native of Anderson, Ind., and is a graduate from Purdue University. For six years he was an engineer in the department of parks of Indianapolis and then was an assistant engineer of the Indianapolis Water Co. Before joining the Indiana Highway Department, he was an associate of Morris Knowles, consulting engineer, of Pittsburgh.

JOHN T. HENDERSON, consulting engineer, Hartford, Conn., has been appointed inspecting engineer by the city of Hartford, on the $1,500,000 Weaver High School and the $1,000,000 high school to be erected on Maple Ave., that city.

MORTIMER G. BARNES, chief engineer of the Waterways Division, Illinois State Department of Public Works, has had the degree of master of engineering conferred upon him by the University of Michigan.

PROF. SAMUEL C. PRESCOTT, acting head of the department of biology and public health of the Massachusetts Institute of Technology since the death of Prof. William T. Sedgwick, has been made permanent head of the department.

R. G. WILSON has resigned as assistant division engineer of the Wyoming Division of the Erie R.R. and is succeeded by JOHN GRAVES, former assistant division engineer of the Rochester Division. Other changes in the engineering department of the Erie R.R. include the transfer of BLAIR BLOWERS from his position as supervisor on the main line to assistant division engineer at Rochester. FRED FISKE, supervisor of the Buffalo Division, takes Mr. Blowers' former position.

HENRY S. CHARRON has been appointed superintendent of the water department of Burlington, Vt. He succeeds J. FRANK KIDDER, resigned.

LLOYD APPLEGATE of Youngstown, Ohio, has been elected village engineer of McDonald, Ohio.

W. M. COTTON of Dayton, Ohio, has been appointed city manager of Ashtabula, Ohio, effective June 1. He will succeed M. H. TURNER who has been city manager since 1918 and who requested more than a year ago that a successor be appointed. Mr. Cotton has served as city manager of several Pennsylvania towns.

CHARLES H. DOWLER, city manager of Wheeling, W. Va., has resigned, the resignation to take effect July 1. He will at that time become a member of the West Virginia State Road Commission. Mr. Dowler succeeds N. P. Whitaker.

JOHN G. HIRSCH, formerly supervising engineeer for Lockwood, Greene & Co., and for Stone & Webster, is now associated with the Benham Engineering Co. of Kansas City, Mo., as principal assistant engineer.
Credit Schafer

R. B. PETTERS, who recently resigned as city engineer of Fond du Lac, Wis., has become associated with the Stein Engineering Co. of Milwaukee as superintendent of construction.

L. D. DAVENPORT, chief engineer of the Oliver Iron Mining Co., Duluth, Minn., has left for Fushun, a city on the South Manchurian R.R., to devise engineering means whereby that city can be moved for the purpose of developing a deposit of coal underlying it estimated to contain 800,000,000 tons.

GEORGE W. PUTNAM has been appointed state sanitary engineer of Missouri, to head the newly-created engineering division of the Missouri State Board of Health, the offices of which are at Jefferson City. Mr. Putnam has been connected with the engi-

neering work of the state boards of Health of Minnesota and California, and during the war was engaged in water-supply work with the Sanitary Corps of the army.

MAJOR D. D. PULLEN, Corps of Engineers, U. S. A., has been ordered to Norfolk to succeed COL. J. C. OAKES as engineer for that district. Col. Oakes has been transferred to New York City.

OBITUARY

A. S. BALDWIN, vice-president, Illinois Central R.R., died of heart disease June 26 while en route from New York to his home in Chicago. He was 61 years old. He was a past-president of the Western Society of Engineers, the American Railway Association and at the time of his death was a candidate for director, District 8, of the American Society of Civil Engineers in the election now in progress.

WILLIAM CREIGHTON BALL, president of Rose Polytechnic Institute, died recently at his home in Terre Haute, Ind., after an illness of several months. Mr. Ball was 75 years old. He was also secretary of the Indiana State Normal School and a member of the board of the state penal farm. Prior to his becoming president of the engineering school he and his brother published the Terre Haute *Gazette*.

A. W. GIBBS, chief mechanical engineer, Pennsylvania Railroad System, died at his home in Wayne, Pa., on May 19. Mr. Gibbs was born in 1856 and was graduated from mechanical engineering Stevens Institute. His professional experience was mostly in the service of the Pennsylvania Railroad from which he rose as an apprentice in the Altoona Shops to become superintendent of motor power and later chief mechanical engineer. For a short period he was connected with other railroads but returned to the Pennsylvania. Mr. Gibbs was president of the American Society for Testing Materials in 1914-15.

BUSINESS NOTES

The AMERICAN ABRASIVE METALS CO., of New York, manufacturer of anti-slip treads for stairs and floors, announces its appointment by the Carborundum Co., of Niagara Falls, to act as U. S. sales representative for the marketing of Carborundum anti-slip tile.

JAMES I. VINCENT has been appointed eastern representative of the Chicago Bascule Bridge Co., with offices in New York City. Mr. Vincent graduated from the University of Michigan in 1896 and was with the Scherzer Rolling Lift Bridge Co. from 1903 to 1912, when he became eastern representataive of the Strauss Bascule Bridge Co.

STROUD & COMPANY, of Omaha, has just sold to R. M. McCrone of Bangkok, Siam, three elevating graders to be shipped immediately to that country. The graders will be used on a large government railroad and irrigation project.

THE STRAUSS BASCULE BRIDGE CO., Chicago, has closed its New York office and has opened a new eastern office at 603 Albee Building, Washington, D. C., in charge of J. C. Eversman.

A. W. FRENCH & CO. is the name of the newly incorporated Illinois firm organized by A. W. French, E. A. Allen, and F. R. French, formerly associated as French & Allen. Land has been acquired and buildings are under construction at 87th St. and the Rock Island tracks, Chicago, for the manufacture, storage and repair of contractors' equipment. The company has been appointed western manager for the Orr & Sembower Co., Reading, Pa., manufacturers of engines, boilers, concrete mixers, and hoisting engines. The French company will also manufacture and distribute the Ord concrete road surfacer described below.

EQUIPMENT AND MATERIALS

Concrete Road Surfacer

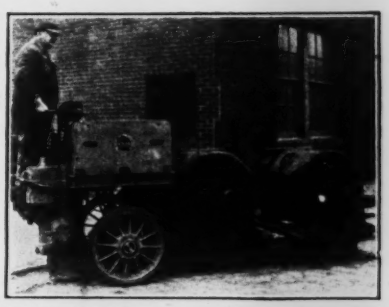
The Ord concrete road surfacer, a new machine developed by William Ord since his resignation from the Lakewood Engineering Co. several months ago, has two heavy strike-off girders

or screeds which level the concrete by using the tops of the road forms as guides, as shown in the accompanying picture. The girders are 8 in. wide on the surface of the concrete and each weighs about 700 lb. for an 18-ft. road machine. They are adjustable for any crown.

Working backward and forward across the road as the machine advances, the girders not only strike off the superfluous concrete but float the remainder. Skin friction between the bottoms of the girders and the surface of the concrete results in a kneading action which is claimed to be sufficient to remove all excess air and water and to produce concrete of maximum density. A. W. French & Co., of Chicago, are the manufacturers and general distributors of the machine.

Electric Truck With 5-Ton Lift

A storage-battery truck for factory and freight purposes which has an elevating platform of 5-tons capacity has been brought out by the Atlas Car & Mfg. Co., Cleveland, Ohio, and is shown in the accompanying view. Its load platform is 74½x30 in. and 11½ in. from the floor in its lowest position, with a lift of 4 in. It has a maximum speed of 8 m. p. h. unloaded and its turning radius is 5 ft. 9 in. for the inside and 12 ft. for the outside. The driving wheels have metal-base rubber tires 4 in. wide and 27¾ in. in diameter. The 10¾ in. steel trailing wheels have double-row ball bearings. Steering is applied to all four wheels and the brakes must be held off by



positive pressure on the treadle or foot lever. Three speeds are provided, but the controller is so interlocked with the brake that only the first speed can be used in starting. A worm gear gives the necessary driving reduction. In the elevating mechanism a motor is coupled to a double-worm reduction gear which drives miter gears carrying crank shafts fitted with rollers bearing against steel plates under the platform. By a half revolution of the cranks the platform is raised 4 in. in 10 seconds with a 5-ton load.

Pipe, Valves and Fittings in War Surplus Auction Sale

The War Department has declared as surplus, and will offer for sale by public auction, at Camp Jackson, S. C., July 25, quantities of materials which, it is believed, will prove of interest to buyers in the market for construction and engineering supplies. Chief among the offerings are several lots of Redwood water pipe, in sizes from 4 to 12 in., and quantities of terra cotta and iron pipe, joints, valves and fittings. Inquiries regarding these offerings should be addressed to the Quartermaster Supply Officer, Candler Warehouse, Atlanta, Ga.

Out-of-the-Ordinary Trade Publications

A good account of the methods of using steel fabric reinforcement for concrete pavements is published by the NATIONAL STEEL FABRIC CO., Pittsburgh, Pa.

An architect's specification handbook has just been issued by the TRUSCON LABORATORIES of Duluth. It is designed to supply information required for specifying waterproofing, damp-proofing, oil-proofing, floor hardeners, and protective finishes. Specifications are given on each right-hand page with a description of the particular product mentioned on the back of that sheet. The handbook contains fifty-two specification sheets.

Full details regarding the construction and use of steel sash, not only in industrial building but in commercial, institutional, and residential structures are described in two illustrated catalogs issued by the DAVID LUPTON'S SONS CO., Philadelphia. The first discusses building design from the point of view of light and ventilation and consists of 191 pages profusely illustrated with drawings and photographs. The second booklet deals with casements of artistic form for fine residences, hotels, and monumental buildings. For both industrial and residential structures, the text gives many new details of industrial sash, doors, partitions, and operating devices.

Business Side of Construction

Facts and Events that Affect Cost and Volume

Lumber Output During May Highest Since 1919

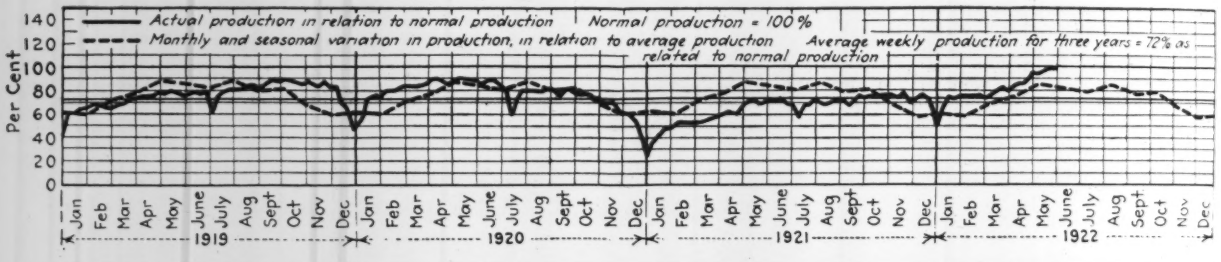
Actual Production and Shipments Compared With Normal and Seasonal Production

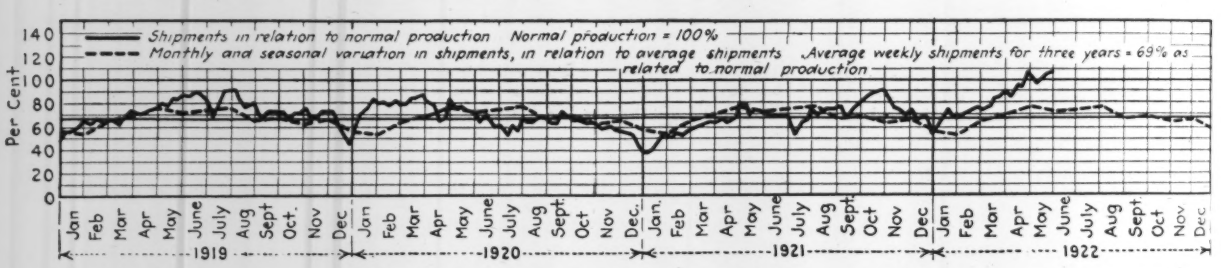
The relation of actual production and shipments to normal production, and to average production and shipments of lumber is shown by these two three-year charts of the National Lumber Manufacturers Association. The most active period is May to August of each year. Since the middle of January, 1922, actual production and shipments exceeded the average, as based upon experience of eight years (1912-1919 inclusive); and in April, 1922, shipments exceeded normal production.

The seasonal line—dotted—on the chart was obtained by averaging the monthly figures for eight years prior to 1920. Compared with this is the fluctuating continuous line of actual production or shipment.

Not until April, 1922, were the high records of 1919 and 1920 equaled in either lumber production or shipments. Before 1922 the highest point reached by production and shipments was about 10 per cent below normal production; the lowest point touched by shipments was 70 per cent below normal production in December, 1920. Latest figures from 394 mills, reporting for the week ending June 17, give shipments 5 per cent above normal with production 3 per cent below normal.

Reports of four associations of the National Lumber Manufacturers Association are included in the compilations from which these charts were graphed: Southern Pine Association, West Coast Lumbermen's Association, Western Pine Manufacturers' Association and North Carolina Pine Association. The principal species represented are Southern long-leaf yellow pine; Douglas fir; Western hemlock; Western yellow and white pine and North Carolina short-leaf yellow pine.


Actual production in relation to normal production
Normal production = 100%
Monthly and seasonal variation in production, in relation to average production
Average weekly production for three years = 72% as related to normal production
Per Cent
1919
1920
1921
1922

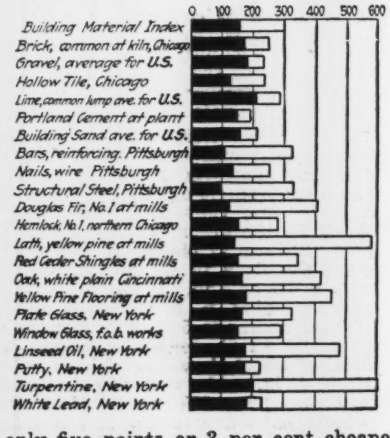

Shipments in relation to normal production
Normal production = 100%
Monthly and seasonal variation in shipments, in relation to average shipments
Average weekly shipments for three years = 69% as related to normal production
Per Cent
1919
1920
1921
1922

Labor Bureau Revised Index Number for May

The Bureau of Labor Statistics has just issued its revised index numbers of wholesale prices for May, as given in the table. The details of this revision as affecting building materials were given in this section of the June 8 issue. It is interesting to note that by this new grouping and weighting building materials as a whole are shown to be only five points or 3 per cent cheaper than a year ago.

REVISED INDEX NUMBERS OF WHOLESALE PRICES, BY GROUPS OF COMMODITIES
(1913 = 100)

	1921 May	1922 April	1922 May
Farm products	118	129	132
Foods	139	137	138
Cloths and clothing	173	171	175
Fuel and lighting	200	194	216
Metals and metal products	138	113	119
Building materials	165	156	160
Chemicals and drugs	134	124	122
Housefurnishing goods	209	175	176
Miscellaneous	126	116	116
All commodities	145	143	148


0 100 200 300 400 500 600
Building Material Index
Brick, common at kiln, Chicago
Gravel, average for U.S.
Hollow Tile, Chicago
Lime, common lump ave. for U.S.
Portland Cement at plant
Building Sand ave. for U.S.
Bars, reinforcing, Pittsburgh
Nails, wire Pittsburgh
Structural Steel, Pittsburgh
Douglas Fir, No. 1 at mills
Hemlock No. 1, northern Chicago
Lath, yellow pine at mills
Red Cedar Shingles at mills
Oak, white plain Cincinnati
Yellow Pine Flooring at mills
Plate Glass, New York
Window Glass, f.o.b. works
Linseed Oil, New York
Putty, New York
Turpentine, New York
White Lead, New York

Comparing prices in May with those of a year ago, as measured by changes in the index numbers, it is seen that the general level has increased 2 per cent. The greatest increase is shown for farm products, in which prices have risen nearly 12 per cent. Fuel and lighting materials have increased 8 per cent and clothing over 1 per cent since May of last year. In all other groups prices have declined, the decrease ranging from less than 1 per cent for foodstuffs to 15¾ per cent for housefurnishing goods.

Production Heavy in May

Pig iron production in May totaled 2,306,679 tons or 234,565 more than in April. Though under the 1913 monthly average, this is the largest output since January, 1921.

Steel ingots produced in May amounted to 3,099,155 tons, an increase of 300,000 over April. Unfilled orders of the U. S. Steel Corporation at the end of May totaled 5,254,228 tons, 157,000 more than the month before.

Laborers in 106 establishments of the iron and steel industry numbered 136,593 in May against 115,709 one year ago, with the combined payroll $514,026 greater. Per capita earnings were 4.6 per cent higher than in April.

Fabricated steel sales amounted to 146,900 tons in May, against 165,900 in April.

Bituminous coal produced in May totaled 20,506,000 tons, with practically no anthracite production.

Gasoline produced in April, the latest figures available, amounted to 472,920,000 gal.

Passenger automobiles and trucks produced in May totaled 252,000. This is considered a record output and prospects point to a continued heavy demand.

Southern pine production during May was but one per cent below normal, while shipments and orders exceeded normal by wide margins. Stocks decreased 6.4 per cent and are 12.1 per cent below normal.

Seven Years' Bidding Prices On New York Roads

Prices Bid on Every Item of Road Construction Averaged for Each Year During 1915-1921

BY W. G. CRANDALL
Assistant Engineer, New York State Highway Commission

Average bidding prices for seven years, of common items entering into road construction in New York State, are summarized in the accompanying table and charts. These averages have been computed from bids received on 3,175 miles of road. They are truly representative not only of the trend of road prices in New York, but they indicate the remarkable upward swing in prices during the war-price period of 1915-1921, for probably most of the roadbuilding portions of the country.

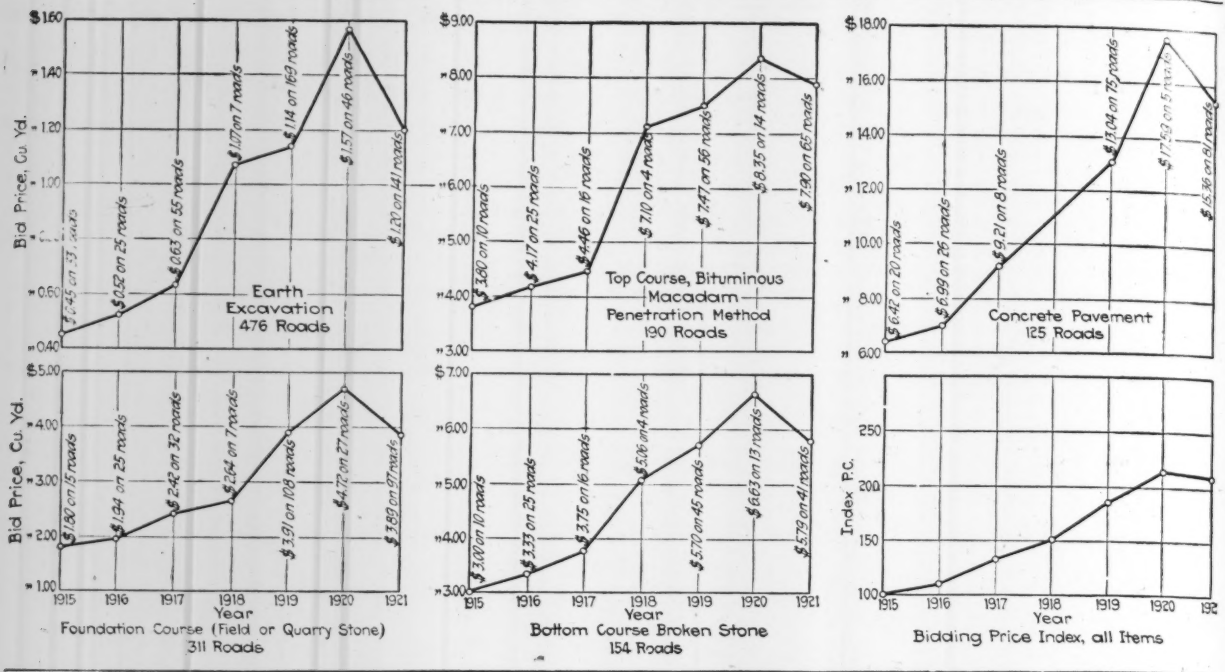
In preparing the table each highway was taken separately and the bids of all contractors for each item were averaged. These averages were tabulated and general averages for the year were computed. By averaging all bids instead of the successful low bids only, it was thought that a more true indication was secured of contracting opinion of fair prices. All obviously unbalanced bids were thrown out of the computation.

In the charts are shown the trend of bidding prices on a few of the leading items of road work. The final chart is a bidding price index curve with 1915 prices as 100 per cent.

(*Charts on p. 1102*)

BIDDING PRICES AVERAGED FOR ALL ITEMS OF ROAD CONSTRUCTION IN NEW YORK FOR SEVEN YEARS, 1915-1921

Item	1915		1916		1917		1918		1919		1920		1921	
	Average Price	No. of Roads	Average Price	No. of Roads	Average Price	No. of Roads	Average Price	No. of Roads	Average Price	No. of Roads	Average Price	No. of Roads	Average Price	No. of Roads
Clearing & Grubbing, mi.	$50.00	30	$98.44	25	$99.96	47	$56.84	7	$67.80	162	$52.83	44	$104.13	150
Earth excavation, cu.yd.	.45	33	.52	25	.63	55	.07	7	1.14	169	1.57	46	1.20	141
Rock excavation, cu.yd.	1.20	28	1.35	25	1.44	44	2.04	7	2.34	146	2.79	42	2.65	134
Overhaul, sta.yd.	0.015	10	.012	25	.015	22	.02	2	.023	65	.0257	25	.019	71
6 in. vitrified pipe, lin.ft.	.20	11	.21	7	.55	3	.....	..	.37	4	.60	1	.39	7
8 in. vitrified pipe, lin.ft.	.35	5	.38	10	.50	4	.....	..	.67	6	.75	2	.74	2
10 in. vitrified pipe, lin.ft.	.40	5	.41	7	.53	3	.....	..	.75	7	.92	4	1.05	4
12 in. vitrified pipe, lin.ft.	.50	10	.54	24	.71	19	.70	3	1.05	52	1.22	18	1.31	49
15 in. vitrified pipe, lin.ft.	.60	5	.73	19	.84	4	.....	..	1.23	19	1.59	9	1.60	14
16 in. vitrified pipe, lin.ft.	.80	1	.62	1	1.35	1	.....	..	1.32	2	.....	..	.....	..
18 in. vitrified pipe, lin.ft.	.90	10	.94	25	1.13	6	.....	..	1.66	31	2.15	12	2.11	30
20 in. vitrified pipe, lin.ft.	1.00	3	.90	1	1.75	1	.....	..	2.20	5	.....	..	2.24	2
24 in. vitrified pipe, lin.ft.	1.60	10	1.66	17	1.98	4	.....	..	2.93	13	2.63	2	3.08	7
6 in. vitrified pipe underdrain, lin.ft.	.20	11	.21	25	.27	28	.35	4	.40	77	.46	3	.42	3
6 in. porous tile underdrain, lin.ft.	.20	25	.17	25	.24	19	.23	3	.31	69	.36	37	.30	125
Concrete leaching basins, each	37.00	6	48.11	7	50.00	4	.....	..	69.28	7	70.63	2	66.78	7
Vitrified leaching basins, each	16.00	4	13.50	4	.....	..	.....	..	27.00	5	.....	..	27.91	10
Catch basins, each	36.00	10	38.86	22	53.12	4	30.00	1	66.10	15	56.56	9	68.80	22
Changing elevation manholes and catch basins, each	4.70	10	5.95	20	5.50	9	10.00	1	9.87	12	8.13	8	9.66	16
Cast iron pipe, ton	33.00	22	38.95	25	49.27	41	52.00	5	76.70	111	80.84	31	81.81	38
Relaying old pipe, lin.ft.	.17	3	.184	16	.155	24	.15	3	.22	86	.23	31	.29	91
Stone filling, cu.yd.	1.05	4	1.38	20	1.55	5	2.00	2	2.69	13	3.34	5	2.52	8
Piles, wood, lin.ft.	.57	3	.36	2	.40	1	.....	..	.....	..	.....	..	1.16	2
Timber and lumber, M.A.B.M.	27.00	10	36.78	25	41.58	25	42.50	6	53.75	109	73.14	30	70.36	108
Rip-rap, cu.yd.	1.50	9	1.73	25	1.97	16	2.25	1	3.01	56	3.44	17	3.33	38
First class concrete, cu.yd.	12.90	1	7.98	2	.....	..	.....	..	13.76	11	20.59	22	16.67	8
Second class concrete, cu.yd.	7.70	32	8.08	25	9.06	53	10.37	7	12.90	146	18.62	41	16.41	12
Third class concrete, cu.yd.	6.30	32	6.91	25	7.95	53	9.66	7	11.82	156	17.77	22	14.70	5
Stone masonry, cu.yd.	3.70	8	3.88	2	4.50	2	5.00	1	7.67	8	9.65	1	6.72	2
Stone curb, lin.ft.	.75	10	.90	7	1.00	2	.....	..	1.25	1	1.58	3	1.76	1
Resetting old curb, lin.ft.	.30	2	.31	13	.....	..	.....	..	.49	5	.42	4	.69	3
Concrete curb, type A, lin.ft.	.40	10	.46	11	.575	4	.65	2	.81	4	.94	4	.84	10
Concrete curb, type B, lin.ft.	.55	2	.62	11	.75	3	.....	..	1.26	8	.....	..	1.05	4
Concrete edging, lin.ft.	.15	10	.20	3	.25	1	.....	..	.55	1	.....	..	.....	..
Cobble gutter, cement joints, sq.yd.	.70	7	.76	25	.805	15	1.22	3	1.29	63	1.40	17	1.05	99
Cobble gutter, sand joints, sq.yd.	.50	27	.56	25	.617	39	.86	6	.95	121	1.26	21	.95	9
Concrete gutter, sq.yd.	.80	7	1.18	21	1.22	6	.....	..	2.02	18	2.17	6	2.20	4
Concrete gutter, cu.yd.	.....	..	.....	..	.....	..	.....	..	.....	..	.....	..	10.91	32
Brick gutter, sq.yd.	1.00	1	1.00	1	.....	..	.....	..	1.65	1	.....	..	.....	..
Metal reinforcement, lbs.	.07	30	.072	25	.086	52	.125	7	.106	153	.119	39	.101	147
Metal reinforcement, pavement, lb.	.....	..	.05	1	.....	..	.....	..	.07	11	.075	5	.076	2
Metal reinforcement, pavement, sq.ft.	.....	..	.015	7	.....	..	.....	..	.025	41	.023	7	.025	79
Miscellaneous iron and steel, lb.	.07	26	.072	25	.086	47	.104	8	.105	129	.115	45	.097	154
Wood guide railing, lin.ft.	.24	10	.27	25	.336	49	.35	7	.48	156	.64	36	.63	18
Concrete wood guide railing, lin.ft.	.....	..	.....	..	1.00	2	.....	..	1.26	4	.69	5	.76	119
Pipe railing, lin.ft.	1.18	2	1.29	10	1.74	6	.....	..	1.95	10	2.27	3	2.71	5
Guide signs, each	2.10	10	2.33	20	2.72	53	3.14	7	3.28	140	3.78	46	4.16	153
Highway number signs, each	2.00	10	2.36	21	1.60	51	1.86	7	1.97	79	2.25	4	1.93	49
Danger-signs, each	2.50	6	2.78	15	3.56	28	3.67	3	5.72	52	5.25	10	5.96	62
Concrete sign posts, each	10.40	10	13.00	19	13.39	51	16.00	7	16.14	85	17.17	11	18.21	13
Screened gravel, cu.yd.	1.80	9	1.64	24	2.00	13	3.10	1	2.79	47	2.75	6	3.20	8
Broken stone, loose measure, cu.yd.	1.80	7	2.02	13	2.04	28	2.65	6	3.57	109	4.23	28	3.81	77
Broken stone, loose measure, ton	2.00	9	2.36	12	2.43	18	1.88	2	3.78	47	.....	..	3.70	8
Foundation course, screened gravel, cu.yd.	1.50	10	1.95	6	2.42	2	.....	..	3.53	10	3.45	2	5.49	3
Foundation course-field or quarry stone, cu.yd.	1.80	15	1.94	25	2.42	32	2.64	7	3.91	108	4.72	27	3.89	97
Bottom course, screened gravel, cu.yd.	2.25	3	2.54	5	3.46	1	.....	..	5.50	1	3.48	1	.....	..
Bottom course, broken stone, cu.yd.	3.00	10	3.33	25	3.75	16	5.06	4	5.70	45	6.63	13	5.79	41
Concrete foundation for pavement, cu.yd.	5.00	10	5.45	25	6.68	8	5.20	1	9.98	7	15.00	1	12.05	5
Top course, water bound macadam, cu.yd.	4.00	12	4.40	25	4.98	18	6.53	5	8.51	39	9.64	2	7.72	2
Cleaning old macadam, sq.yd.	.025	6	.004	1	.....	..	.....	..	.023	3	.....	..	.....	..
Scarifying & reshaping old macadam, sq.yd.	.04	5	.037	6	.....	..	.....	..	.042	5	.085	3	.....	..
Surface treatment with bit. material, gal.	.11	5	.011	25	.141	8	.12	1	.169	26	.162	3	.....	..
Top course, bit. mac. pentration, cu.yd.	3.80	10	4.17	25	4.46	16	7.10	4	7.47	56	8.35	14	7.90	65
Bitulithic pavement, sq.yd.	1.50	1	.....	..	1.69	3	.....	..	2.05	1	.....	..	.....	..
Concrete pavement, cu.yd.	6.42	20	6.99	26	9.21	18	15.25	1	13.04	75	17.59	5	.....	..
Sulphite liquor, gal.	.15	1	.15	1	.18	1	.....	..	.202	5	.256	2	.....	..
Asphalt block, sq.yd.	1.40	1	1.90	4	1.63	2	.....	..	.....	..	.....	..	2.43	2
Brick pavement (Type 1), sq.yd.	1.40	20	1.55	18	1.76	5	2.20	1	2.78	3	.....	..	2.94	5
Stone block pavement, sq.yd.	2.60	3	2.75	4	3.50	1	.....	..	6.00	2	7.35	1	.....	..
Restoring shoulders, lin.ft.	.04	3	.04	3	.....	..	.....	..	.108	5	.....	..	.....	..
Bit. mat. "A," penetration method, gal.	.11	10	.112	25	.131	12	.21	3	.132	49	.245	12	.15	65
Bit. material "T" binder, gal.	.12	10	.111	8	.126	4	.22	1	.157	5	.15	2	.....	..
Bit. material "T" cold application, gal.	.....	..	.135	25	.131	5	.....	..	.....	..	.19	4	.16	1
Commercial gran. calc. chloride, ton	17.50	5	19.60	25	19.39	10	18.00	1	26.31	17	30.00	1	.....	..
Manipulation gran. calc. chloride, ton	1.50	5	1.91	25	1.96	10	1.50	1	2.54	20	3.00	1	.....	..
Reinf. conc. pipe, 12 in. diam., lin.ft.	.....	..	.....	..	.....	..	.....	..	2.48	1	2.26	1	2.19	23
Reinf. concrete pipe, 15 in. diam., lin.ft.	.....	..	.....	..	.....	..	.....	..	.....	..	2.45	3	2.65	33
Reinforced conc. pipe, 18 in. diam, lin.ft.	.....	..	.....	..	.....	..	.....	..	3.48	1	3.59	2	3.00	62
Reinf. concrete pipe, 24 in. diam., lin.ft.	.....	..	.....	..	.....	..	.....	..	4.20	1	4.66	5	4.54	57
Reinf. concrete pipe, 30 in. diam., lin.ft.	.....	..	.....	..	.....	..	.....	..	.....	..	5.86	2	5.71	21
Reinf. concrete pipe, 48 in. diam., lin.ft.	.....	..	.....	..	.....	..	.....	..	12.60	1	.....	..	.....	..
Portland cement, bbl.	.....	..	.....	..	.....	..	.....	..	3.10	2	3.54	23	3.40	152
Cement conc. pavement 1-2-4 (*), cu.yd.	.....	..	.....	..	.....	..	.....	..	.....	..	10.26	11	9.56	20
Cement conc. pave. 1-1½-3½ (*), cu.yd.	.....	..	.....	..	.....	..	.....	..	.....	..	11.96	3	8.59	42
Cement conc. pave. 1-1½-3 (*), cu.yd.	.....	..	.....	..	.....	..	.....	..	.....	..	10.55	9	8.42	19



Weekly Construction Market

THIS limited price list is published weekly for the purpose of giving current prices on the principal construction materials, and of noting important price changes on the less important materials. Moreover, only the chief cities are quoted.

Valuable suggestions on costs of work can be had by noting actual biddings as reported in our Construction News section.

The first issue of each month carries complete quotations for all construction materials and for the important cities. The last complete list will be found in the issue of June 1; the next, on July 6.

Steel Products:	New York	Atlanta	Dallas	Chicago	Minneapolis	Denver	San Francisco	Seattle	Montreal
Structural shapes, 100 lb.	$2.68	+$3.65	$4.00	$2.48	$2.86	$3.60	$3.10	$3.60	$3.75
Structural rivets, 100 lb.	3.60	+4.35	5.50	3.10	3.90	4.45	4.25	3.75	6.50
Reinforcing bars, ¾ in. up, 100 lb.	2.58	3.50	3.50	2.38	2.76	3.67½	2.55	3.60	2.90
Steel pipe, black, 2½ to 6 in. lap, discount	61%	61.15%	45%	59½%	61.9–5%	44%	49.1%	53%	30.00
Cast-iron pipe, 6 in. and over, ton	48.80@49.80	48.50	51.50	44.10	50.50	57.00	51.00	53.00	50.00
Concreting Material:									
Cement without bags, bbl.	2.40@2.50	2.34	2.25	2.07	2.34	2.90	—2.63	—2.90	2.48
Gravel, ¾ in., cu.yd.	1.75	1.85	2.25	1.80	1.50	1.75	2.25	1.10	1.50
Sand, cu.yd.	1.00	1.15	2.25	1.80	1.00	0.75	1.50	1.10	1.25
Crushed stone, ¾ in., cu.yd.	1.75	1.90	2.73	1.60	2.25	3.50	2.25	3.00	2.00
Miscellaneous:									
Pine, 3x12 to 12x12, 20 ft. and under, M.ft.	49.00	39.00	38.00	45.00	40.00	49.00	25.00	+22.50	82.00
Lime, finishing, hydrated, ton	15.80@16.80	22.50	25.00	18.00	29.00	24.00	22.00	24.00	21.00
Lime common, lump, per bbl.	2.75@3.18	1.75	2.50	1.40	1.40	2.70	1.75	2.80	11.00
Common brick, delivered, 1,000.	+24.60	+11.00	11.15	11.00	16@17	12.00	15.00	14.00	16.00
Hollow building tile, 4x12x12, per block	Not used	.075	.115	.0707	.082	.08	....	.12	.09
Hollow partition tile 4x12x12, per block	.1112	.0707	.115	.0657	....	.08	.108	.11	.....
Linseed oil, raw, 5 bbl. lots, gal.	+.88	+.94	1.07	.96	+.99	1.08	1.04	.86	1 09
Common Labor:									
Common labor, union, hour	.75	.35	.....	.80	.....	.50@.55	.56¼	.50@.60	.....
Common labor, non-union, hour	.44@.60	.20	.25	.72½	.35@.50	.35@.50	.47½@.50	.....	.20@.30

Explanation of Prices—Prices are to contractors in carload lots unless other quantities are specified. Increases or decreases from previous quotations are indicated by + or — signs. For steel pipe, the prevailing discount from list price is given: 45-5% means a discount of 45 and 5 per cent. Charge is 15c. per 100 lb. for cutting reinforced steel into 2-ft. lengths or over.

New York quotations delivered, except sand, gravel and crushed stone, alongside dock; common lump lime, in 280-lb. bbl. net, and hydrated lime f.o.b. cars; tile "on trucks"; linseed oil and cast-iron pipe f.o.b.

Chicago quotes hydrated lime in 50-lb. bags; common lump lime per 180-lb. net.

Minneapolis quotes on fir instead of pine. Brick, sand and hollow tile delivered. Cement on cars. Gravel and crushed store quoted at pit. We quote on brown lime per 180-lb. net; white is $1.70 for Kelly Island and $1.55 for Sheboygan. Common labor not organized.

Denver quotes on fir instead of pine. Cement "on tracks"; gravel and sand at pit; stone on cars; lime, brick, hollow tile and lumber on job. Tile price is at warehouse. Linseed oil, delivered, in wooden bbl. Common lump lime per 180-lb. net.

Atlanta quotes sand, stone and gravel per ton instead of cu.yd. Common lump lime per 180-lb. net.

Dallas quotes lime per 180-lb. bbl. Steel, cement, cast-iron pipe and crushed stone f.o.b. cars, other materials delivered.

San Francisco quotes on Heath tile, 5½ x 8 x 11½. Prices are all f.o.b. warehouses except C. I. pipe, which is mill price plus freight to railway depot at any terminal. Common lump lime per 180-lb. net. Lumber prices are to dealers in yards at San Francisco, for No. 1 fir common.

Seattle quotes on Douglas fir instead of pine. Lump finishing lime per 180-lb. net. Hollow building tile delivered. Hydrated lime in paper sacks. Sand and gravel at pit.

Montreal quotes on long-leaf yellow pine, short-leaf, $67.50. Sand, stone, gravel and lump lime per ton. Lime and tile are delivered; cement, sand, gravel and stone on siding; brick f.o.b. plant; steel and pipe at warehouse. Hollow tile per ft. Cement price is in Canadian funds (the Canadian dollar stands at 98.12 cents). Bag charge is 80c. per bbl. Discount of 10c. per bbl. for payment within 20 days from date of shipment. Steel pipe per 100 ft. net; 2½-in., $30; 6-in., $110.